THURSDAY, DECEMBER 13, 1877

HYDROPHOBIA

POPULAR alarm has of late been aroused by the publication of an unusual number of cases of death from this most terrible disease, and interest and hope have been excited by the statement that, at last, a drug has been found—curare—which does exert such an influence that at least one case is said to have been rescued from otherwise certain death. We propose to discuss briefly in this article the chief points in the natural history of hydrophobia, to examine what light, if any, science has thrown upon its nature, and to inquire what reasons there are for believing in the alleged efficacy of drugs in its treatment.

Hydrophobia is a disease which never occurs spontaneously in man, being invariably communicated to him by the bite of some animal affected with it—commonly by the dog, more rarely the cat, more rarely still the fox and wolf. The bite induces the disease by permitting the absorption of the saliva of the diseased animal, the peculiar poison or "*materies morbi*" of the disease being contained in the saliva. Inasmuch, then, as man only becomes affected with hydrophobia through the intermediation of the lower animals, it will be necessary to consider it, first of all, as it makes itself manifest in them.

It has been, and still is, a subject of dispute amongst veterinarians whether hydrophobia, or "rabies," was originated spontaneously in the dog. Avowedly the immense majority of cases of the disease can be proved to have been due to the bites of rabid animals; some cases do occur, however, in which it is stated that there was no possibility of contact with a diseased animal, and these are held to prove the occasional spontaneous origin of the disease. Now, whilst we are not prepared absolutely to contradict such a surmise, and to allege that at no time, and under no circumstances, hydrophobia originated spontaneously, we do hold that there is no better evidence of such a new origin *now* than there is of the spontaneous generation of the poisons which induce small-pox, scarlet fever, or measles. In the case of these diseases, as in that of hydrophobia, it does sometimes happen that some of the links in the chain of evidence are lost which are required to prove the connection between one case of disease and its precursor, but the exceptional cases do not outweigh the immense mass of evidence which proves that each of the diseases previously mentioned is as certainly the offspring of a previous case as is each animal or plant at present living the offspring of a pre-existing parent organism. We shall then probably be quite right in assuming that not only is it true of hydrophobia as it affects man, but of the disease as it is manifest in all animals, that it is always due to the inoculation of poison from a diseased into a healthy organism.

In commencing a description of hydrophobia we must point out that whilst the disease is always more or less prevalent, periods when it becomes much more frequent occur from time to time. Within the present century, especially between 1800 and 1830, several such outbreaks occurred; in this respect hydrophobia resembles other diseases of the zymotic class, which, though always more or less prevalent, only occasionally prevail with epidemic intensity. We must assume that at this period the circumstances which are required for the spread of the particular disease are specially favourable, though it is only rarely that we can do more than surmise what these special circumstances really are.

In the dog, as indeed in all animals, there is a period of latency, or as it is technically termed, of "incubation," which intervenes between the inoculation of the poison of hydrophobia and the development of any symptoms; this period varies remarkably: it may be as short as a week, or as long as three months; the greater number of cases occurring, however, between the twentieth and fiftieth days after the poisonous wound has been inflicted. It must not be supposed that the bite of a rabid dog always induces the disease in other dogs which it bites; a certain number of such bites prove abortive. Thus, out of 131 dogs which had been bitten by, or inoculated with, the virulent saliva of certainly rabid dogs, only sixty-three fell victims. The failures in these cases are to be explained in several ways. In some cases it is probable that the saliva was not active, just as sometimes the liquid from the vaccine vesicle, when fairly tested, is found to be incapable of reproducing vaccinia; in other cases the poisonous saliva has doubtless been prevented from penetrating the wound, having been retained by the hair and cuticle of the bitten animal; finally, in a third class of cases, it must be assumed that the bitten animal did not offer conditions required for the development of the disease. A case is, indeed, recorded, on the best authority, in which a pointer dog was caused to be bitten on seventeen separate occasions by dogs affected with rabies, without the disease being induced.

The period of incubation having passed, the first symptoms of rabies usually consist in a change in the temper of the dog, which becomes sullen and snappish, and which often bites those around it, even without any provocation. This prominence of the cerebral symptoms in the early stages of hydrophobia in the dog is very remarkable, and contrasts, as will be seen in the sequel, with the phenomena of the disease in man. It is evidenced not merely by the tendency to bite, but by the whole changed aspect of the animal, which is now observed to be obviously ailing. The appetite becomes capricious, food often being refused, and all kinds of rubbish swallowed, and often, though by no means invariably, the dog utters dismal howls. It is in this stage that the dog often wanders from home, and apparently under the influence of maniacal excitement, rushes on, biting all dogs which it meets, and often all human beings who happen to come in its way. It is to be noted that the dog does not exhibit any of the dread of water which is so painfully evident in the disease as it affects man; this depends upon the fact that in the dog there appears to be little, if any, tendency to spasm of the muscles of deglutition. As the disease advances palsy of the posterior extremities often occurs; in other cases a peculiar paralysis of the muscles connected with the lower jaw sets in, so that the suffering animal is unable to utter any sound, and is said to be suffering from "dumb-madness." Throughout the disease there is usually an increased secretion of viscid saliva. The

whole course of hydrophobia in the dog is run in from four to eight days, the majority of cases proving fatal about the fourth or fifth day. This short description of rabies or hydrophobia, as it affects the dog, is almost exactly applicable to the disease as it occurs in other domestic animals; a maniacal excitement and a tendency to injure men and animals with which they come in contact being as characteristic of herbivorous animals as it is of dogs, cats, foxes, and wolves.

Having, then, before us an outline of hydrophobia as it affects the lower animals, let us compare with it the disease as it is observed in man.

In the first place as to the frequency with which the bite of a mad dog is followed by hydrophobia. No general satement can be made on this matter, as the results vary very greatly according to the part bitten, according to the treatment to which the bitten part is subjected, &c. For instance, bites inflicted upon parts protected by clothing are followed by hydrophobia much less frequently than those in which the hand or face is injured, the poison in the former case being absorbed by the intervening clothing.

Next, as to the period of incubation. In man this varies even more than in the case of the dog; the majority of cases of human hydrophobia have, however, a period of incubation which varies between thirty and fifty days, though exceptional cases occur in which many months have elapsed between the infliction of the bite and the supervention of the symptoms; these remarks might be illustrated by reference to cases which have occurred in England, and which have been recorded in the medical journals during the last two years; the shortest period of incubation observed within this period having been eighteen days, and the longest nine months. During the period of incubation there is nothing to distinguish a bite inflicted by a rabid dog from the bite of a healthy dog. The study of some of the recorded cases of the disease would almost lead to the conclusion that in man there is during the period of incubation a tendency to nervous depression and melancholia which is a precursor of the terrible symptoms which are to follow; it is obvious, however, that great caution ought to be exercised in the interpretation of such mental symptoms, which are after all in many cases but the necessary and logical results of an injury of which the possible consequences are but too well known and correspondingly dreaded. If we except these symptoms of depression and melancholy there are no characteristic phenomena which intervene between the infliction of the bite and the onset of the attack of hydrophobia.

In a certain number of cases the advent of the disease is ushered in by pain of a neuralgic character in the bitten part; this appears to be merely an evidence of the general feeling of illness which then supervenes, rather than any evidence of the specific nature of the bite. More commonly the first phenomena are merely vague symptoms of feeling very unwell, accompanied often by an intense feeling of melancholy. A deep sighing character of the inspirations, or even paroxysmal attacks of difficulties of breathing, with some pain in the throat and pain in the præcordial region often follow. Beyond the feeling of impending evil, there is no mental symptom at this stage of the disease at all comparable with those observed in the lower animals. Next in the order of accession is the difficulty which the poor patient experiences in swallowing; this, at first slight, symptom soon acquires a terrible intensity; the patient is troubled by an agonising thirst, and yet dares not drink; any attempt to drink gives rise to a terrible spasm of the muscles engaged in deglutition, and apparently to a simultaneous spasm of the muscles engaged in inspiration so powerful that he dreads suffocation. An analysis of the symptoms at this stage leads one, indeed, to the opinion that swallowing is often dreaded because of, and is indeed impeded by, the spasm of the inspiratory muscles which it induces. Then follows a stage in which often, though by no means invariably, the patient becomes subject to delusions, and often violently maniacal, and this is succeeded by a stage of exhaustion and quiet which ushers in the fatal termination.

If we have sketched with some degree of minuteness the outlines of a very painful picture, we have done so because a knowledge of them was absolutely essential before we could attempt to consider what light science has thrown upon this dread disease, and what reliance is to be placed upon the remedies which have been suggested for its cure.

We shall now, in the first place, consider the results of pathological investigations relating to hydrophobia. Are there not some well marked and constantly present lesions of the great nerve-centres corresponding in some measure to the symptoms which manifest themselves during life? The older observations generally concur in showing that the brain and spinal cord are the seat of congestions which are, however, not sufficiently constant in their localisation to admit of any conclusions being drawn from them. And, since the time when pathological anatomy attained its present development and accuracy, but few persons sufficiently competent to draw accurate conclusions from their observations have had the opportunity of working at the subject. From the observations of Benedict (*Virchow's Archiv*, 1875), it resulted, that in addition to more or less widely spread congestion, there occur granular degeneration of nerve-cells, and of nerve-fibres in various parts of the brain. Subsequently Wassilieff, working under the direction of Prof. Botkin, of St. Petersburg, described (*Centralblatt f. d. med. Wissenschaft*, 1876, p. 625) *a*, some alterations in the nerve-cells of the medulla oblongata, the outlines and nuclei of which are indistinct and the contents cloudy; *b*, a large accumulation of corpuscles of the size of white blood-cells in the interstitial connective tissue of the brain, in the peri-vascular canals and immediately surrounding them; and *c*, the presence of a highly refracting substance in the peri-vascular spaces, especially in the cortical layers of the cerebral hemispheres. Somewhat akin to them are the observations of Dr. Gowers who found in the medulla oblongata after death from hydrophobia, accumulations of cells, resembling white blood-cells, in the vicinity of the blood-vessels, and also in the nervous substance. But what do all these observations indicate? In all probability the accumulations of white cells are caused by the emigration of white blood corpuscles from the blood, so that they are to be held as supporting the older observations which alleged congestions of the brain to be frequently present, and the other pathological changes

noticed by the three observers to whom we have referred, cannot as yet be adequately interpreted.

Pathological anatomy then helps us a little in our attempts to elucidate hydrophobia. Can we obtain better results by reasoning upon the symptoms and course of the disease from the standpoint of physiology? Hardly, but we may make the attempt. Physiology necessarily cannot help us to understand the nature of the peculiarly subtle poison which can lurk so long in the system without betraying its presence by any symptom, but she may help us in explaining the phenomena which it induces. Of this poison we know as little, if not less, than of the other poisons which are capable of inducing zymotic diseases. Each of those diseases appears to depend upon a definite *materies morbi* upon the presence of which the peculiar phenomena of each depend; but the periods which elapse between introduction of the poison and the manifestation of the disease varies in each case, no less than the course and duration of the disease, and the organs and tissues of the body which are affected. Thus, in scarlet fever the poison induces changes in the epitheliated surfaces of the body, manifested by the rash, the sore throat, the acute kidney affection; in typhoid fever anatomical changes of the most obvious nature are wrought in the alimentary canal, and lead to the special dangers of the disease; in typhus, again, the poison, whilst producing changes in the general nutrition of the body, and exciting a specially-marked action upon the brain proper (as evidenced by the marked affection of all mental processes), produces no typical anatomical changes. These diseases all illustrate the fact that the poison of each zymotic disease affects certain tissues and organs of the body, and it might be easily shown that it is by the implication of particular functions that each of these poisons *usually* induces death. Is there, in the case of hydrophobia, any evidence that it affects specially any particular organ of the body? Yes; a physiological analysis of the disease reveals the fact that its symptoms depend upon an affection of the nerve-centres, and especially of the medulla oblongata.

These essential symptoms are—the spasmodic difficulty of breathing, which depends upon a spasm of the *inspiratory* mechanism and a spasmodic affection of the group of muscles engaged in deglutition. The nerve-centres which preside over respiration and the co-ordinated movements of deglutition are situated in the medulla oblongata, and it is these centres which appear to be peculiarly affected. The reflex excitability of this portion of the nervous apparatus becomes first of all heightened so that a stimulus applied to the mucous membrane of the gullet, which in health would give rise to a normal contraction of the muscles of deglutition, travelling on to the morbidly irritable medulla, throws the centre presiding over deglutition into a state of tonic spasm so intense as to be acutely painful; not confining its action to this one centre, the stimulus is able to throw the contiguous respiratory centre into a similar state of spasm, and the patient runs the risk of suffocation because the movements of the thoracic box, which are essential causes of the passage of air into and out of the lungs, cease for a time. The mechanism of suffocation in these cases resembles that observed when the upper end of the pneumogastric nerve is stimulated by a succession of strong induction shocks, except that in hydrophobia the abnormal effect is doubtless due not to the intensity of the stimulus, but rather to the heightened excitability of the nerve-centres implicated. Apparently a subtle animal-poison acting upon an intensely vulnerable but limited part of the nervous mechanism induces in it an action similar in kind to that produced by strychnia upon the spinal cord. Under the influence of this well-known poison the excitability of the nerve-centres in the cord is heightened, so that a stimulus reaching it by an afferent nerve which would in the healthy unpoisoned condition lead to the reflex and painless contraction of but a small group of muscles, will be able to throw the nerve-cells of the whole cord into intense activity, and as a result occasion the characteristic and terribly painful convulsions of strychnia poisoning. There are, indeed, other facts besides those previously mentioned which point to a state of irritation and increased nervous excitability of the medulla and contiguous nerve-centres. Thus it has been observed that occasionally the pulse has been abnormally slow, a result almost certainly due in these cases to an excitation of the inhibitory centre in the medulla—of that centre which exerts a moderating or restraining influence upon the heart's action; further, it not unfrequently happens that towards the close of the hydrophobic stage, stimuli which were at first only capable of inducing the spasms of deglutition and inspiration, are able to bring on attacks of general convulsions. Here we have a still further extension of the effects of the irritation due to an extension of the reflex excitability from the medulla to the spinal cord.

Our analysis of the symptoms of hydrophobia reveals that as a rule the spasmodic stage terminates before death, which is not produced, as in strychnia poisoning, by the mechanical result of the convulsions—suffocation—but apparently by a more general, though we confess unknown, action of the poison on the organism generally. We know as little of the mode of death in this case as we do in that of scarlet fever, or diphtheria, or typhus, each one of which *may* produce death without leading to the anatomical results which, at any rate in the case of the two former of these diseases are their usual accompaniments. Zymotic poisons may indeed leave as few traces of their action as the simpler and better known poisons such as prussic acid or morphia, so that whilst we cannot disregard the local manifestations or changes which they induce, and which of themselves are a frequent source of danger, we must admit that they are in many cases—nay in most cases—secondary in importance to the more general phenomena which are the expression of the poisonous influence affecting the organism.

(*To be continued.*)

ANCIENT HISTORY FROM THE MONUMENTS

Ancient History from the Monuments. The History of Babylonia. By the late George Smith; edited by A. H. Sayce. *The Greek Cities and Islands of Asia Minor.* By W. S. W. Vaux. (Society for Promoting Christian Knowledge, 1877.)

THE Society for Promoting Christian Knowledge has been doing a very useful work in acquainting the public with the historical results of recent Oriental research

in a cheap and handy shape. The work has been wisely placed in the hands of those who have themselves been pioneers in the task of discovery, and the reader has thus been secured against the errors and unfounded conclusions almost inseparable from second-hand information. The histories of Egypt, Assyria, and Persia, have now been followed up by those of Babylonia and Asia Minor, and the fact that the history of Babylonia was the last literary work which Mr. George Smith, the indefatigable Assyrian explorer, lived to accomplish, gives a melancholy interest to it over and above that of its subject matter. Indeed, the materials for reconstructing Babylonian history are still but scanty, and must remain so until systematic excavations can be made among the buried cities and libraries of ancient Chaldea. With the exception of a few early bricks and a few dedicatory inscriptions of Nebuchadnezzar and his successors, it is from the clay tablets of Nineveh that almost all our knowledge of the sister kingdom has been derived. Even Babylonian chronology is still in an uncertain and tentative condition, and the fragments of the Babylonian historian, Berosus, help us but little. Whole periods must still be left blank, and though one or two dates, like the conquest of the Elamite king, Cudur-nankhundi, in B C. 2280, can be fixed by the aid of later monuments, the relative position of even whole dynasties has not yet been settled. Our acquaintance with the mythical epoch is quite as great as with the historical epoch ; the Assyrians preferred the legends of the rival monarchy to a record of its glories, and while, therefore, we now have in detail the stories of the creation, of the flood, or of the hero Izdubar, we know comparatively little of the political changes which passed over the Babylonia of history. Compared, however, with what we knew of them a few years back, even this limited knowledge seems large and accurate, and the best evidence of this is the volume which Mr. Smith has written, and which would have been an impossibility but a short time ago. Those who wish to learn what light has been thrown by cuneiform discovery on this important section of ancient history cannot do better than refer to his book. The importance of Babylonia for the history of culture and civilisation is daily becoming more manifest ; the early Accadian population of the country, who spoke an agglutinative language and invented writing, left a rich inheritance of art, science, mythology, and religious ideas to their Semitic successors, and through them to the Jews and Greeks. The latter were influenced partly through the Phœnicians, partly through the nations of Asia Minor. Mr. Vaux's volume on the Greek cities of Asia Minor is therefore a suitable companion to Mr. Smith's "History of Babylonia." His difficulty in compiling it must have been the converse of Mr. Smith's, as here it was not the meagreness but the superabundance of materials which was likely to cause embarrassment. His selection, however, is good and judicious, and the book he has produced is at once instructive and readable. He has not forgotten to invoke the assistance of the latest discoveries ; the first few pages are devoted to an account of Dr. Schliemann's life and discoveries, and the researches of Newton, Wood, and Fellows, have been largely drawn upon. Considering the space at his command, Mr. Vaux must be congratulated upon the amount he has been able to cram into it, and, so far as we can see, no city or fact of importance has been omitted. Both volumes are appropriately illustrated, and the "History of Babylonia" contains a copy of a bronze image of an ancient Chaldean monarch recently brought to the British Museum, and interesting on account of the rarity of such early monuments. Their value is further increased by the addition of indices, and the editor of Mr. Smith's volume has added a chronological table of the Babylonian kings, and an explanatory list of proper names.

FRENCH POPULAR SCIENCE

Musée Entomologique Illustré. Les Papillons : Organisation, Chasse, Classification. 80 Plates and 260 Woodcuts. *Les Coléoptères : Organisation, Mœurs, Chasse, Collections, Classification.* 48 Plates and 335 Woodcuts.

Anatomie et Physiologie de l'Abeille. Par Michael Girdwoyn. 12 Lithographic Plates.

Les Champignons. Par F. S. Cordier. 60 Chromolithographs and 8 Woodcuts.

Les Prairies Artificielles. Par Ed. Viaune. 127 Woodcuts.

Les Ravageurs des Forêts et des Arbres d'Alignement. Par H. De la Blanchère. 162 Woodcuts.

Les Ravageurs des Vergers et des Vignes ; avec une Étude sur le Phylloxera. Par H. De la Blanchère. 160 Woodcuts.

Le Chalumeau. Analyses Qualitatives et Quantitatives. Guide Pratique. Traduction libre du Traité de B. Kerl. Par E. Jannettaz.

Les Aliments. Determination Pratique de leurs Falsifications. Par A. Vogl. Traduction par Ad. Focillon. 160 Woodcuts. (All published by J. Rothschild, Rue des Saints-Pères, Paris.)

WE have received the preceding batch of works from the house of Rothschild of Paris. This is not the first time we have been able to show not only how worthily M. Rothschild is maintaining his position as one of the first publishers of popular science works of the time, but how eagerly such works are read, and how highly they are appreciated in France. It is impossible to speak too highly of the honest work which has been put into each of the volumes, while many of them are written by men whose names are widely known on this side the Channel. As is proper in this style of literature, the text is equalled by the illustrations. Why is it that in the matter of illustrated books such as those before us, the French finished product is so far superior to nine-tenths of those published on this side the water? Nothing can exceed the perfection of many of the hundreds of woodcuts in the above volumes, while we have rarely seen more finished specimens of chromolithography than those to be found in some of the volumes.

We cannot think that the French public is so far beyond our own in its appreciation of science, as to make the publication of similar works in our own country hopeless. We shall therefore give an analysis of each of the above works in a single article, with a view of showing the treatment adopted abroad in popularising the branches of science with which the volumes deal, instead of devoting

one to each of them in turn, which we should have been quite justified in doing, having regard to their value.

Of the two volumes on the Natural History of Insects, which are published by a society of French and foreign entomologists, vol. i. is devoted to the Coleoptera, and comprises their organisation and their different orders, with a short description of each, and woodcuts showing their different stages of development. These are followed by other useful matter, and then, in the second part, we come to "Le Monde des Scarabées." The stag-beetle is here taken as an example of his family to show the anatomy of these insects. The description of their dwellings and instincts is clear, and written in such a style that it may be understood and enjoyed by those not versed in entomology. This part occupies a good portion of the book. In the pages devoted to the hunting, preparing, and keeping of beetles, beginners may find every information they require; pincers, pins, and nets are all shown, as well as the necessary requisites for the knapsack. A list of the principal entomological works is given, after which we have a lengthy classification and iconography of European coleoptera, illustrated with forty-eight plates beautifully coloured by hand.

The arrangement of volume ii., on Butterflies, is very similar to the above, and contains thirty coloured plates illustrating the butterfly, caterpillar, and chrysalis, together with the plants on which these are most frequently to be found.

"The Anatomy and Physiology of the Bee," is taken from volume vi. of the "Memorials of the Polish Society of Exact Sciences in Paris," and translated into French by M. Pillain. This work consists of twelve lithographic plates which obtained medals of merit both at the Universal Exhibition at Vienna and from the Royal and Imperial Society of Agriculture of Cracow. On these plates we have 172 figures of the various parts of a bee, greatly magnified. It is scarcely necessary to add that these are extremely well finished. In the folio we have the memoir itself, a book of forty pages, which first introduces us to the bees of different countries and the bibliography of the subject. In chapter i. the author describes the exterior parts of the bee, and in the second and third the interior and more complicated, such as the muscles, nervous system, circulation of the blood, &c. The work terminates with explanations of the figures. Altogether this is a valuable addition to an entomologist's library, and does great credit to the society from which it has emanated.

In M. Cordier's book on Fungi we have much valuable information. In the first place he treats generally of the organisation of fungi, their physiology, mode of reproduction, and geography, how to distinguish the edible from the poisonous, and he shows us how to extract this poison; he tells how this works on the animal economy and the best means of counteracting it. In the second part all the fungi useful to man are chronicled, with detailed descriptions of each order and drawings from nature.

M. Cordier has adopted Persoon's classification in preference to any other, as he takes it to be more practical; indeed he dedicates the book to his memory as the "Créateur de la Science Mycologique." The drawing and colours of the sixty chromolithographs are well worthy of note. The book also contains a glossary, table of common, and one of the scientific, names of the fungi.

The author has evidently endeavoured to make his subject as interesting and complete as possible. The style of the popular portion of the book is admirable, and *bon vivants* will be glad to be informed that there are eight pages dealing with the proper way of cooking truffles.

The two small books by H. de la Blanchère—one on the enemies of forest trees, with 162 engravings of insects and larvæ, the other on the enemies of orchards and vines similarly illustrated, form part of a large series now well known and highly appreciated in France. We have already noticed some of them, and these are in no way inferior to the former ones.

"Plants used for Food," written by A. Vogl, of Prague, translated into French by Ad. Focillon, is a practical guide for detecting the adulteration of flour, coffee, chocolate, tea, and the like.

"The Blowpipe," by E. Jannettaz, is extremely well arranged, and is a thoroughly practical guide for engineers, mineralogists, &c.; the information is accurate and condensed, and M. Jannettaz's name is a guarantee of its scientific value.

OUR BOOK SHELF

The Fifth Continent, with the Adjacent Islands; being an Account of Australia, Tasmania, and New Guinea, with Statistical Information up to the Latest Date. By C. H. Eden. With Map. (London: Society for Promoting Christian Knowledge; no date.)

THIS volume contains much information on the Australian colonies, but it is somewhat desultory and incomplete. It is not a children's book, and it will not satisfy those who are in quest of full information on the subject. It affords some idea of the history, people, and products of Australia and New Guinea, but it would be better to cut out much of what is said about the history and the people and give more space to well-digested information about the resources of the countries.

Notes by a Field Naturalist in the Western Tropics. By Henry H. Higgins, M.A. (Liverpool: Edward Howell, 1877.)

THIS is a readable record of observations made during a yacht voyage to the West Indies by Mr. Higgins, who is president of the Liverpool Naturalists' Field Club. Mr. Higgins went over well-trodden ground, and therefore we need not look for any novelties in this little volume, although much of it is interesting. The chief purpose of the voyage, undertaken by Mr. Cholmondley, the owner of the yacht, was to observe and collect tropical birds. Mr. Higgins collected, also, many specimens, both zoological and botanical, from sea and land, which are now being arranged. He may possibly, he states, publish an account of the biology of the voyage.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.]

The Radiometer and its Lessons

PROF. FOSTER'S clear representation of what he conceives to be the effect of rarefaction reduces the question between us to a definite issue.

Having assumed that heat is flowing across an intervening layer of gas from a hotter surface A to a colder surface B, he

says:—"Then, I imagine, the flow of heat through the gas will take place *as though* there were, in contact with each solid surface, a layer of gas whose temperature is throughout the same as that of the contiguous solid, and whose thickness is equal (or at least proportional) to the mean length of path of the molecules." Without these layers of uniform temperature or whatever may produce an equivalent effect it follows directly from Prof. Foster's reasoning that the rate at which heat is communicated is, as I maintain it is, independent of the density, whereas *if there were* any such layers I should at once admit the force of Prof. Foster's reasoning. The whole question turns therefore on the existence of these layers of uniform temperature.

Now what evidence of such layers have we? No experimental evidence certainly; and not only has the kinetic theory not as yet been applied to explain their existence but it is easy to demonstrate that according to this theory no such layers or any equivalent can exist. For in order that the condition of heat may remain unaltered it is necessary that the rate at which heat is transmitted across all surfaces parallel to the solid surfaces which can be drawn through the gas should be the same. And the rate at which heat is transmitted is for small variations of temperature proportional to the degradation of temperature, hence if there were a layer of uniform temperature no heat could be transmitted.

It is surely incumbent on Prof. Foster in assuming the existence of these layers to give some sort of proof in support of his assumption, but not one word does he say!

I cannot allow this to pass without pointing out that the description which Mr. Stoney has given of my view is grossly wrong and is certainly not to be gathered from anything I have written. Mr. Stoney carefully turns my position. He makes out that I have explained the action in question as *arising* from *convection currents*, whereas I have from first to last maintained that it is these currents which oppose and eventually overcome the action. He makes out that my theory takes no account of molecular motion, whereas, in truth, it takes no account of anything but molecular motion, the effect of the expansion of the gas being so obviously trivial that I have never even mentioned it.

Your readers may judge of this by comparing the first of the following quotations, which is from Mr. Stoney's letter, with the others which are from my own papers, and are the only expressions, not mathematical, which I have given of my views as to action in the question:—

Mr. Stoney's.

"Prof. Osborne Reynolds's explanation is based on the fact that when a disc with vertical sides is heated on one side and exposed to a gas, a convection current sets in, which draws a continuous supply of cold gas into contact with the hot surface of the disc. As this cold gas reaches the disc it is expanded, and thus its centre of gravity is thrown further from the disc. Accordingly, the disc, if freely suspended, will move in the opposite direction so as to keep the centre of gravity of the gas and disc in the same vertical line as before, and, if not freely suspended, will suffer a pressure tending to make it move in that direction. If I have understood Prof. Reynolds aright, this is both a correct and full description of his explanation as last presented."

My Own.

"Whenever heat is communicated from a hot surface to gas, the particles which impinge on the surface will rebound with a greater velocity than that with which they appropriate; and consequently the effect of the blow must be greater than it would have been had the surface been of the same temperature as the gas.

"And, in the same way, whenever heat is communicated from a gas to a surface, the force on the surface will be less than it otherwise would be, for the particles will rebound with a less velocity than that at which they approach.[1]

"These forces arise from the communication of heat to or from the surface from or to the gas. These forces will be directly proportional to the rate at which the heat is communicated; and since this rate has been shown by Prof. Maxwell to be independent of the density of the gas, these forces will be independent of the density of the surrounding medium, and their effect will increase as the density and convection-currents diminish."[2]

[1] *Proceedings*, Royal Society, 1874, p. 407.
[2] *Phil. Mag.*, November, 1874, p. 3.

The first of the quotations from my papers is followed by a mathematical expression on which I have depended for completeness, and from this expression, in which neither convection currents nor the expansion of the gas have any place whatsoever, it follows that whenever heat is steadily diffusing *in'o* or *through* a gas, the momentum transmitted across any surface in the direction in which the heat is diffusing will be greater than that transmitted in the opposite direction by a quantity proportional to the rate at which the heat diffuses, divided by the square root of the absolute temperature of the gas.

As to the value of what follows in Mr. Stoney's letter, I must leave it to your readers to decide. He proceeds to claim that his own theory has the advantage of being based on molecular motions, he says:—

"My explanation, on the other hand, is based on *molecular* motions which go on in the gas without causing any molar motion, and is independent of convection currents."

Then having thus attributed to me an explanation, I never even thought of offering, and having assumed the true base of my theory as alone belonging to his, he proceeds to show wherein I am wrong. And in every subsequent position which he attributes to me, he is as wrong as he is in his first statement.

Under these circumstances it would be useless for me to enter upon questions as to how far "diffusion," according to the kinetic theory may be more "sluggish" than Mr. Stoney's "penetration," or to discuss further the possibility of his "Crookes's layers."

In my last letter I showed that the condition of a gas which Mr. Stoney called a "Crookes's layer" was impossible, and I do not see that Mr. Stoney has improved his position by showing that he had arrived at the possibility of the condition by making the false assumption "*that gas is a perfect non-conductor of heat.*"

Wherein Mr. Stoney's views are at variance with the results of the laborious investigations of Maxwell, Clausius, Thomson, and others, he may best convince himself by referring to the works of these authors. Until he has read my papers and explained the discrepancies between his views and the generally-accepted laws of gases, I do not see that we have any common ground for discussion.

OSBORNE REYNOLDS

November 30

Mr. Crookes and Eva Fay

IF Mr. Wallace had read my letter in NATURE of November 29 with a little more attention, he would have seen that I did *not* refer to the *Daily Telegraph* "as an authority in a matter of scientific inquiry," but that the account I gave of Mr. Crookes's "scientific tests" was given *in Mr. C.'s own communication to the 'Spiritualist,'* which would have been reproduced without abridgment if the columns of NATURE could have admitted it.

What I hold myself pledged to show (in NATURE, if it pleases, as well as in the new edition of my Lectures) is that the "tying-down by electricity" described by Mr. Crookes in the *Spiritualist*, is no more effective in preventing the performance of juggling tricks than Eva Fay's *ordinary* tying-down under which her tricks were publicly reproduced two years ago by Messrs. Maskelyne and Cooke. And since Mr. Crookes made no mention of the *extraordinarily* sensitive galvanometer he used, which is described for the first time by Mr. Wallace in the last number of *Fraser*, I only consider myself bound to show the *method* by which, with *ordinary* apparatus, the electric test may be evaded—the trained skill of the acute *trompeuse* being very probably required to meet the more severe test now first specified.

Mr. Wallace seems to me to have been a little hasty on another point. "The supposed *exposure* of Eva Fay in America," he says, "was no exposure at all, but a clumsy imitation." As this is merely Mr. W.'s *dictum* founded upon an imperfect newspaper report, I prefer to trust the judgment of the eye-witnesses who have publicly testified to *the completeness of the exposure*. Among these are not only three of the ablest men in New York (the Rev. Dr. Bellows, Ex-Surgeon-General Mott, and Dr. Hammond), but the reporters of the very newspaper referred to which had previously shown a decided leaning to the claims of spiritualism. And their judgment is confirmed by the fact (which Mr. Wallace probably considers as a newspaper fiction, but of which I have independent testimony) that *Eva Fay was forced by the local authorities to take out a licence as a juggler* as a condition of the continuance of her public performances.

The fundamental difference between Mr. Wallace and myself as to the validity of testimony in regard to the "occult" comes out so strongly in this case that we have really no common

ground for a discussion which I cannot consider it profitable to continue.

WILLIAM B. CARPENTER

The Glacial Geology of Orkney and Shetland

OWING to an accident I did not see your number of September 13 containing my letter on the glacial geology of Orkney and Shetland and Prof. Geikie's article (vol. xvi. p. 414), until my return from Scotland a few days ago. Otherwise I should have troubled you sooner with a few observations thereon.

In the first place I wish to thank Prof. Geikie for the very courteous manner in which he has referred to the remarks of an outsider who has ventured to intrude on what the Professor has made, to such an extent, his own peculiar province.

In the next place I am glad to find that upon what was the most important fact in my statement, viz., the absence of raised beaches or other signs of recent elevation of the land in Orkney, Prof. Geikie agrees with me.

I call this the most important because it bears directly on the theory of wide-spread changes in the relative level of sea and land owing to secular causes, such as a change in the axis of the earth's rotation, or in the position of its centre of gravity. If it can be proved that the difference of level, which caused the raised beaches of the south of Scotland, and extended north along the coast of Ross and Sutherland, dies out as we proceed further north, and disappears altogether in Orkney and Shetland, it is truly a crucial experiment which shows that these raised beaches are due to local elevations of the land, and not to a general sinking of the sea.

This is the conclusion to which Prof. Geikie points, though he naturally finds it difficult to understand why the upheaval, so marked in Sutherland, did not affect Caithness and Orkney.

I believe I can add a few facts which may assist in removing these doubts.

At one of the places in Caithness mentioned by Prof. Geikie, where the existence of a raised beach might be possible, viz., in the sheltered Bay, between Freswick and Wick, I believe there is one, though less strongly marked and at a lower elevation than those in similar situations in Sutherland. I allude to a terrace which bounds the links of Keiss Bay, about half a mile inland from the present coast-line. I cannot speak positively, not having seen it for some years; but my recollection is that it is a perfect miniature reproduction of the terraces round Brora and other bays in Sutherland. If so, it is a positive proof that the elevation of the land died out towards the north, and we might reasonably suppose that somewhere about the line of the Pentland Firth was the neutral axis, on one side of which the land rose, while on the other it fell.

Be this as it may, the *fact* is, I think, incontrovertible that Orkney did not share in the southern movement of elevation. This rests not only on the absence of raised beaches, forming terraces, which might possibly have disappeared, but still more on the absence of all traces of marine action, such as pebbles, sand, or shells, on the low plains which must have been submerged.

I would ask Prof. Geikie to consider whether the single instance of the Loch of Stennis is not conclusive. If the sea had ever stood twenty or thirty feet higher relatively to the land than it now does, the whole plain up to the hills must have been a sheltered, shallow, inland fiord.

As the land rose to its present level this must have left not only a terraced beach at the foot of the hills, which might possibly have disappeared (though it is hard to see why it should have done so in such a sheltered situation), but the whole plain must have been a raised sea-bottom, strewed over with pebbles, sand, and shells. These could not have disappeared, and as they are nowhere visible and the plain consists everywhere of the ordinary rock, with a thin mantle of soil resulting from its disintegration by ordinary atmospheric causes, I am, I think, justified in assuming it to be proved that Orkney did not share in the recent movement of elevation which affected the rest of Scotland.

Now one word as to glaciation. I can assure Prof. Geikie that I do not think for a moment of setting my authority against his, and that if he is right in the instances of glaciation he tells us he has observed in Orkney, so far from being disappointed, I shall be pleased, for it will clear up what has long seemed to me a perplexing anomaly.

Of course Orkney must have experienced the full rigour of the glacial period, and it is only natural to expect that it should show the same abundant signs of glaciation as the adjoining counties of Scotland. Prof. Geikie will therefore excuse me if I still retain a little of that healthy scepticism which is so conducive to the establishment of truth, and venture to plead that judgment may be suspended until there is further evidence. I do so mainly because the Professor's own statement is that during his visits to Orkney his attention was devoted mainly to the old red sandstone, and his remarks on glaciation were only incidental. Now there are some proofs of glaciation which are so obvious that there can be no mistake about them, others which may easily be mistaken, and which require close examination by a practised eye directed specially to them, to arrive at a just conclusion.

Boulders of foreign rock, perched blocks, rocks unmistakably rounded and polished by the ice plane, are among the former. But striæ require great practice and careful examination to be sure of them in a district of finely laminated sandstones which weather constantly into parallel lines or grooves. Stony clay again, from disintegrated rock, is often so like boulder clay that it requires close observation to distinguish one from the other. And finally where steep hills have crumbled away and filled up many places in the narrow valleys between them with their *débris*, as at Hoy, the appearances are very like those of glacial moraines.

Now I observe that nearly all the conclusive proofs of glacial action are wanting in Prof. Geikie's enumeration. He has not seen, or heard of anyone who has seen, a single boulder or perched block, or even a single piece of foreign stone in Orkney.

As regards boulder-clay I would join issue on his instances, taking especially that of Kirkwall Bay, because it is typical of the other cases and so easily accessible that the facts can readily be verified.

I believe it to be disintegrated and not boulder clay, for the following reasons:—

1. The clay is not compact like that of genuine boulder-clay, but of looser structure, and often clearly made up of minute splinters of the disintegrated rock.

2. The stones in the clay are never foreign stones, and are not scattered irregularly, as if shot out into a huge rubbish heap, as in true boulder-clay, but arranged for the most part so that the original lines of stratification can be followed.

3. If the section which resembles boulder-clay be followed up, it will be found to merge insensibly in what is unmistakably the common disintegrated surface soil of the district.

There only remains the question of *roches moutonnées*, and here I speak with the greatest diffidence, for certainly Prof. Geikie ought to know a great deal better than I whether a hummock of rock is or is not "admirably ice-worn and striated" like those behind Stromness.

I can only say that I have looked at them often, and they appear to me to be very different from the *roches moutonnées* of which I have seen so many in Scotland, Wales, and Switzerland. They are not rounded, smooth, and polished, as if planed into shape by some gigantic tool, but simply irregular hummocks of rock, sometimes smooth and sometime rough, according to accidents in the bedding and weathering of the strata. So at least they seem to me, and even in the valleys of Hoy, where, if anywhere, there were local glaciers, the sections shown by the small streams and low coast-line, always, I believe, exhibit the same appearance of sandstone strata, coming at an angle to the surface, and with their edges not planed off, but passing gradually into surface soil by disintegration.

Of course I make these statements subject to correction. It may be that I have failed to see things because my eye is not sufficiently educated. But when we couple what is, I believe, absolutely certain, viz., the absence of the more prominent and obvious proofs of glaciation in the form of boulders and foreign rocks, with the equally certain fact that Orkney was an exception to the general rule of recent elevation, I think Prof. Geikie will admit that the interests of science will be promoted by any remarks which may lead to reasonable doubts, and therefore to conclusive investigation, as to the fact whether Orkney does or does not give proof of having been covered by a great polar ice-sheet during the glacial period.

S. LAING

36, Wilton Crescent, S.W.

Explosions

I HAVE been waiting to see if Mr. Galloway's paper on "Explosions in Mines" published in NATURE, vol. xvii. p. 21, would lead to any correspondence. Your readers may be interested in an incident reported to me by the late Dr. Böttinger, of Messrs. Allsopp's brewery, Burton-on-Trent.

In their new brewery, near the railway station, the crushed malt is lifted from one floor to another by a series of cups revolving on a leathern band. The casing, which incloses the band, is full of floating malt dust while the revolution is going on, and on opening one of the doors of the casing a puff of malt-dust is sent out into the room. Soon after the brewery was opened, a workman went with an undefended light to make some examination of the working of the leathern band, and on opening the door of the casing an explosion followed; not of a very serious character, but enough, I think, to throw the band out of gear. The cause of the explosion is evident; the rapid combustion of the fine malt dust with which the air puffed out into the room was charged.

Dr Böttinger died a few years since, but it would probably not be difficult to get accurate details of the accident from Messrs. Allsopp and Sons. A. MACKENNAH

Bowdon, December 11

Means of Dispersal

IN his great work, "Insecta Maderensia," Mr. Wollaston remarks upon the great affinity in the coleopterous fauna of Madeira with that of Sicily, and in his "Coleoptera Hesperidum," on the *northern* character of that of the Cape Verde Isles. Mr. Andrew Murray also found that out of 275 Cape Verde species 91 were common to the Canaries and 81 to the Madeiran group. The last author would seem to rely on the efficacy of now submerged continents as a means of transmission between the two areas.

Towards the end of the fifteenth and commencement of the sixteenth century, the Portuguese carried the sugar-cane from Sicily to Madeira and the Canaries. The means of introduction would probably be the same then as now; the young shoots of cane would be conveyed in boxes or baskets of earth from one locality to the other, as the writer once carried young cane plants from Car Nicobar *viâ* Rangoon to Penang, and has seen the same arrive in the last locality from the West Indies. There can be little doubt that many of these plants must have been carried from Sicily to the Atlantic Isles before a successful or sufficient introduction was made, and with the earth in which the plants were conveyed, many geodephagous and other coleoptera would find an enforced means of migration. The sugar-cane is also reported as having been introduced into Cyprus from Asia, and transplanted from there to Madeira, thus adding another link to the localities in which these coleopteral affinities have been detected.

It is not proposed that this was the sole, but only a probable means of the transmission of common forms in the coleopteral faunas of these widely-separated districts. The number of causes which have been factors to the same in the past may be in an inverse ratio to our knowledge of them. W. L. DISTANT

Supplementary Eyebrows

I MET a gentleman a few days ago who has on either side of the forehead a supplementary eyebrow branching off from the superciliary ridge near the supra-orbital notch, and passing obliquely upwards and outwards for about ¾ inch across the forehead. Beneath these brows, which contain large and coarse hairs, are lines of soft down-like hair, one on either side occupying the usual position of the eyebrows. Since my attention was drawn to this subject I have noticed that many persons have a short secondary spur of hairs at the points indicated. Artists, I believe, have noticed this deviation from the normal eyebrow-line, as we occasionally observe it in portraits of Puck and other mischievous sprites.

There is a spot about midway between the orbits in animals that I have examined (namely, horses, dogs, and cats), whence the lines of hair-insertion into the skin radiate in various directions. If we consider the secondary eyebrows of man as a reversion to an ancestral type, we must conclude that our hairy progenitors also possessed such a radiating point of hair insertion upon their foreheads, and that the secondary eyebrows are only remnants of a hairy covering which originally enveloped the whole face. W. AINSLIE HOLLIS

Brighton

Diffusion or Cohesion Figures in Liquids

WITH reference to the above, allow me to relate some experiments made several years ago, and easily repeated.

1. Take a tall precipitate glass, fill it with water, drop into it a piece of lump or refined sugar and four or five grains of common salt. Let the vessel remain quiet, so that when the sugar is dissolved there may be different densities in the fluid from top to bottom. Then lightly touch the surface with a piece of lunar caustic (silver nitrate), and observe the figure which results.

2. The experiment may be repeated with sugar, diluted sulphuric acid, and barium chloride, the figures varying with the proportions of the ingredients used.

3. Take a common tumbler glass filled with water, dissolve in it half a tea-spoonful of common salt. Touch the surface of the solution with the point of a pen filled with ordinary black ink, and the characteristic figures are produced. F.R.S.

Brighton, December 12

Meteor

AT 8h. 13m. (± 2m.) P.M. on December 9, a brilliant meteor passed from 32 Cameleopardalis (± 1°) through μ Lyræ (± 1°), and disappeared about 6° beyond; time of passage, 1·6 (± ·3) sec.; mag., 8 (± 2) χ Lyræ; colour, emerald green; track, yellow, visible 1 second; seen from 51° 24′ 43″ N., 2′ 13″ E. This may enable a northern observer to fix the position.

Bromley, Kent W. M. F. P.

ON THE CAUSATION OF SLEEP

THE last number of *Pflüger's Archiv* (vol. xv., p. 573) contains the following interesting note by Dr. Strümpell:—

"In the autumn of last year there was received into the medical clinik of Leipzig a youth, aged 16, in whom various phenomena of anæsthesia gradually developed themselves to an extent which has very rarely been observed. The skin of the whole surface of the body was completely insensible, and that in respect to every kind of sensation. The most powerful electric current—a burning taper held to the skin—was not able to produce any pain or even a sensation of touch. Almost all the accessible parts of the mucous membrane of the body exhibited the same insensibility to pain. Also all those sensations which are classed together under the name of 'muscular sense,' were entirely absent. The patient, when his eyes were closed, could be carried about round the room, his limbs could be placed in the most inconvenient positions without his being in any way conscious of it. Even the feeling of muscular exhaustion was lost. In addition there came on also a complete loss of taste and smell, amaurosis of the left eye, and deafness of the right ear.

"In short, here was an individual whose only connection with the outer world was limited to two doors of sense—to his one (right) eye, and his one (left) ear. Moreover, both these remaining doors could at any time be easily closed, and in this way it was possible to investigate the consequences of completely isolating the brain from all external stimulation through the senses. I have frequently made the following experiment, and often showed it to others:—If the patient's seeing eye was bandaged and his hearing ear was stopped, after a few (usually from two to three) minutes the expression of surprise and the uneasy movements which at first showed themselves ceased, the respiration became quiet and regular; in fact the patient was *sound asleep*. Here, therefore, the possibility of artificially inducing sleep at any time in a person simply by withholding from the brain all stimulation by means of the senses was realised.

"The awakening of the patient was as interesting as the sending him to sleep. He could be awakened by an auditory stimulation, as, for example, by calling into his hearing ear or by visual stimulation, by allowing the stimulus of light to fall upon his seeing eye; but he could not be woke by any pushing or shaking. If he was left to himself he did eventually wake up of his own accord in course of the day, after the sleep had lasted many hours, the awakening being due, it might be, to intrinsic stimuli started in the brain, or it might be to slight external unavoidable stimuli acting through his still functional sense organs, and making themselves felt in consequence of the sensitiveness of the brain being increased during the repose of the sleep."

THE MODERN TELESCOPE[1]

II.

WHETHER the telescope be of the first or last order of excellence, its light-grasping powers will be practically the same; there is therefore a great distinction to be drawn between the illuminating and defining power.

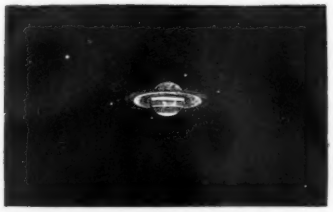

FIG. 5.—Saturn and his moons (general view with a 3¾ inch object-glass.)

The former as we have seen depends upon size (and subsidiarily upon polish), the latter depends upon the accuracy of the curvature of the surface.

If the defining power be not good, even if the air be perfect, each increase of the magnifying power so brings out the defects of the image, that at last no details at all are visible, all outlines are blurred or stellar character is lost. Even with the best telescopes the power should not be strained.

The testing of a glass therefore refers to two different qualities which it should possess. Its quality as to material and the fineness of its polish should be such that the maximum of light shall be transmitted. Its quality, as to the curves, should be such that the rays passing through every part of its area shall converge absolutely to the same point, with a chromatic aberration not absolutely *nil*, but sufficient to surround objects with a faint violet light. With the reflector we have to consider the brilliancy of the surface and the perfection of curvature.

In close double stars, therefore, or in the more minute markings of the sun, moon, or planets, we have tests of its defining power; and if this is equally good in the instruments examined, the revelations of telescopes as they increase in power are of the most amazing kind.

A 3¾-inch suffices to show Saturn with all the detail shown in Fig. 5, while Fig. 6 shows us the further minute structure of the rings which comes out when the planet is observed with an object-glass with an aperture of 26 inches.

In the matter of double stars, a telescope of 2 inches aperture, with powers varying from 60 to 100, should show the following stars double:—

Polaris.	γ Arietis.	α Geminorum.
α Piscium.	ρ Herculis.	γ Leonis.
μ Draconis.	ζ Ursæ Majoris.	ξ Cassiopeæ.

A 4-inch aperture, powers 80-120, reveals the duplicity of—

β Orionis.	α Lyræ.	δ Geminorum.
ε Hydræ.	ζ Ursæ Majoris.	σ Cassiopeæ.
ε Boötis.	γ Ceti.	ε Draconis.
Leonis.		

[1] Continued from p. 68.

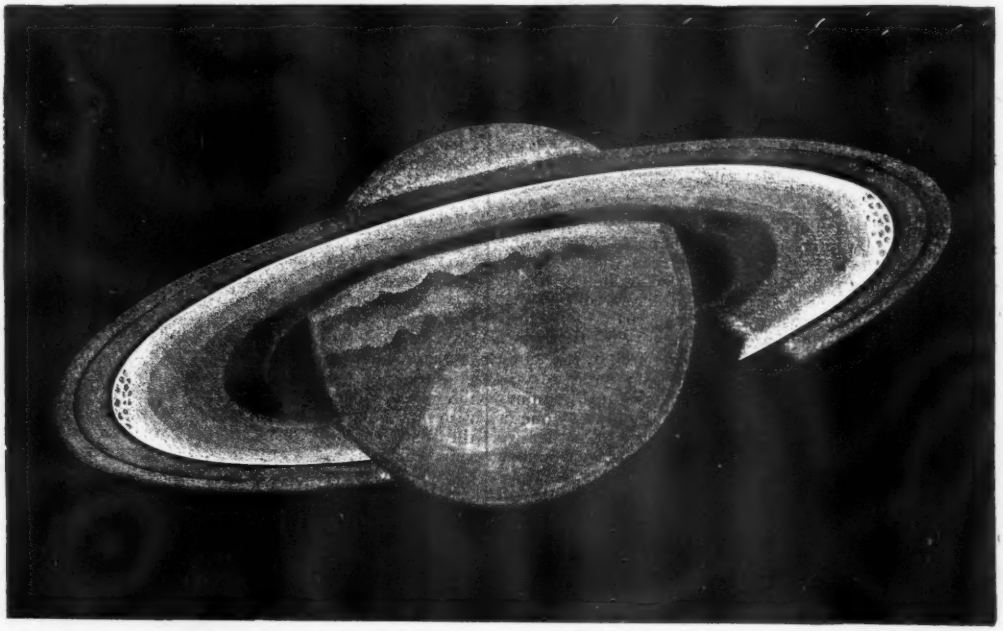

FIG. 6.—Details of the ring of Saturn observed by Trouvelot with the 26-inch Washington Refractor.

A 6-inch, powers 240-300—

ε Arietis.	20 Draconis.	ζ Herculis.
32 Orionis.	κ Geminorum.	ζ Boötis.
λ Ophiuchi.	ι Equulei.	

An 8-inch—

δ Cygni	Sirius.	μ^2 Herculis.
γ^2 Andromedæ.	19 Draconis.	μ^2 Boötis.

The "spurious disk," which a fixed star presents, as seen in the telescope, is an effect which results from the passage of the light through the circular object-glass, or its reflection from a circular mirror; and it is this

appearance which necessitates the use of the largest apertures in the observation of close double stars, as the size of the star's disk varies, roughly speaking, in the inverse ratio of the aperture.

In our climate, which is not so bad as some would make it, a 6- to an 8-inch glass is doubtless the size which will be found the most constantly useful; larger apertures being frequently not only useless, but hurtful. Still, 4 or $3\frac{3}{4}$ inches are apertures by all means to be encouraged; and by object-glasses of these sizes, made, of course, by the *best* makers, views of the sun, moon, planets, and double stars, may be obtained, sufficiently striking to set many seriously to work as amateur observers, and with a prospect of securing good, useful results.

Observations should always be commenced with the lowest power, gradually increasing it until the limit of the aperture, or of the atmospheric condition at the time, is reached. The former may be taken as equal to the number of hundredths of inches which the diameter of the object-glass contains. Thus, a $3\frac{3}{4}$-inch object-glass, if really good, should bear a power of 375 on double stars where light is no object; the planets, the moon, &c., will be best observed with a much lower power.

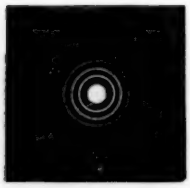

FIG. 7.—Appearance of diffraction rings round a star when the object-glass is properly adjusted.

FIG. 8.—Appearance of same object when object-glass is out of adjustment.

Care should be taken that the object-glass is properly adjusted. And we may here repeat that this may be done by observing the image of a large star out of focus. If the light be not equally distributed over the image, or the diffraction rings are not circular, the screws of the cell should be carefully loosened, and that part of the cell towards which the rings are thrown very gently tapped with wood, to force it towards the eyepiece, or the same purpose may be effected by means of the set-screws always present on large telescopes, until perfectly equal illumination is arrived at. This, however, should only be done in extreme cases; it is here especially desirable that we should let well alone. In the case of mirrors, instructions for adjustment are generally given by the maker.

The convenient altitude at which Orion culminates in these latitudes renders it particularly eligible for observation; and during the first months of the year, our readers who would test their telescopes will do well not to lose the opportunity of trying the progressively difficult tests, both of illuminating and separating power, afforded by its various double and multiple systems, which are collected together in such a circumscribed region of the heavens that no extensive movement of their instruments—an important point in extreme cases—will be necessary.

Beginning with δ, the upper of the three stars which form the belt, the two components will be visible in almost any instrument which may be used for seeing them, being of the second and seventh magnitudes, and well separated. The companion to β, though of the same magnitude as that to δ, is much more difficult to observe, in consequence of its proximity to its bright primary, a first magnitude star. Quaint old Kitchener, in his work on telescopes, mentions that the companion to Rigel has been seen with an object-glass of $2\frac{3}{4}$-inch aperture; it should be seen, at all events, with a 3-inch. The bottom star in the belt is a capital test both of the dividing and space-penetrating power, as the two bright stars of the second and sixth magnitudes, of which the close double is composed, are exactly $2\frac{1}{2}''$ apart, while there is a companion to one of these components of the twelfth magnitude about $\frac{3}{4}''$ distant. The small star below, which the late Admiral Smyth, in his charming book, "The Celestial Cycle," mentions as a test for his object-glass of 5·9 inches in diameter, is now plainly to be seen in a $3\frac{3}{4}$. The colours of this pair have been variously stated.

That either our modern opticians contrive to admit more light by means of a superior polish imparted to the surfaces of the object-glass, or that the stars themselves are becoming brighter, is again evidenced by the point of light, preceding one of the brightest stars in the system composing σ. This little twinkler is now always to be seen in a $3\frac{3}{4}$-inch, while the same authority we have before quoted—Admiral Smyth—speaks of it as being of very difficult vision in his instrument of much larger dimensions. In this very beautiful compound system there are no less than seven principal stars; and there are several other faint ones in the field. The upper very faint companion of λ is a delicate test for a $3\frac{3}{4}$-inch, which aperture, however, will readily divide the closer double of the principal stars which are about $5''$ apart.

These objects, with the exception of ζ, have been given more to test the space-penetrating than the dividing power; the telescope's action on 52 Orionis will at once decide this latter quality. This star, just visible to the naked eye on a fine night, to the right of a line joining α and δ, is a very close double. The components of the sixth magnitude are separated by less than two seconds of arc, and the glass which shows a *good wide black division* between them, free from all stray light, the spurious disc being perfectly round, *and not too large*, is by no means to be despised.

Then, again, we have a capital test object in the great nebula to which reference has already been made.

The star to which we wish to call especial attention is situate (see Fig. 4) opposite the bottom of the "fauces," the name given to the indentation which gives rise to the appearance of the "fish's mouth." This object, which has been designated the "trapezium," from the figure formed by its principal components, consists, in fact, of six stars, the fifth and sixth (γ' and a') being excessively faint. Our previous remark, relative to the increased brightness of the stars, applies here with great force; for the fifth escaped the gaze of the elder Herschel, armed with his powerful instruments, and was not discovered till 1826, by Struve, who, in his turn, missed the sixth star, which, as well as the fifth, has been seen in modern achromatics of such small size as to make all comparison with the giant telescopes used by these astronomers ridiculous.

Sir John Herschel has rated γ' and a' of the twelfth and fourteenth magnitudes—the latter requires a high power to observe it, by reason of its proximity to a. Both these stars have been seen in an ordinary 5-foot achromatic, by Cooke, of $3\frac{1}{2}$-inches aperture, a fact speaking volumes for the perfection of surface and polish attained by our modern opticians.

Let us now try to form some idea of the perfection of the modern object-glass. We will take a telescope of eight inches aperture, and ten feet focal length. Suppose we observe a close double star, such as ξ Ursæ, then the images of these two stars will be brought to a focus side by side, as we have previously explained, and the distance by which they will be separated will be dependent on the focal length of the object-glass.

If we take a telescope ten feet long and look at two stars 1° apart, the angle will be 1°; and at ten feet off the distance between the two images will be something like $2\frac{1}{10}$ inches, and therefore, if the angle be a second, the lines will be the $\frac{1}{360000}$th part of that, or about $\frac{1}{17000}$th part

of an inch apart, so that in order to be able to see the double star ξ Ursæ, which is a 1″ star, by means of an eight-inch object-glass, all the surfaces, the 50 square inches of surface, of both sides of the crown, and both sides of the flint glass, must be so absolutely true and accurate, that after the light is seized by the object-glass, we must have those two stars absolutely perfectly distinct at the distance of the seventeen hundredth part of an inch, and in order to see stars ½″ apart, their images must be distinct at one-half of this distance or at $\frac{1}{3400}$th part of an inch from each other.

J. NORMAN LOCKYER

(*To be continued.*)

BIOLOGICAL NOTES

CLASSIFICATION OF DECAPOD CRUSTACEANS.—In this well-defined group, the position of the anomurous forms (hermit-crabs, &c.) has often been the subject of doubt. The special adaptations of some genera for particular modes of life have caused them to be thrown together; and no doubt they agree in possessing neither the powerful abdomen of the lobsters, nor the very much aborted one of the crabs. Yet the anomurous forms include markedly contrasted groups. The family Hippidæ, with its lobster-like cephalothorax and firm abdomen, differs greatly in aspect from the hermit-crabs. *Hippa talpoida*, a small species found along the whole eastern coast of the United States, inhabits sandy beaches exposed to the waves, at a zone very near low-water mark. It has a smooth oval form, and short and stout thoracic legs (second, third, and fourth pairs), enabling it to burrow backwards in the sand with marvellous rapidity. In life the antennæ are peculiarly crossed, with the flagella curved round the mouth so that the setæ, with which they are densely covered, all project inwards, and the function of the antennæ appears to consist chiefly in the removal of all parasitic growths or foreign bodies from the anterior parts of the body. The appendages of the mouth are not adapted for prehension or mastication, and the alimentary canal is found loaded with fine sand. The thoracic appendages have neither external nor superior elements (exopodites, epipodites); while the office of protecting and cleaning the gills is discharged by the small limbs corresponding to the fifth pair of ambulatory legs in lobsters, which are curved upwards and hidden beneath the carapace. The development of this form has been recently carefully described by Mr. Sidney Smith, of Yale College, in the *Transactions* of the Connecticut Academy, vol. iii. p. 311. They pass through larval stages very analogous to the zoëa stages of crabs, only being destitute of a large dorsal spine; and they then assume a form like the brachyuran megalops, with large eyes, and powerful abdominal swimming legs. But in this condition they buried themselves in sand with great alacrity. Thus it is determined that the embryonic development of Hippa, as well as of Albunea, studied by Claus, agrees much more closely with that of crabs proper than with hermit crabs or lobsters; and this publication by Mr. Smith furnishes an important addition to the evidence favouring the view that the Anomura are a heterogeneous group made up of specialised families of Brachyura and Macrura.

THE AMERICAN BISON.—Mr. J. A. Allen's valuable "History of the American Bison," so sumptuously produced by the Geological Survey of Kentucky and the Harvard Museum of Zoology, has excited so much interest that to supply the demand for it Dr. Hayden has republished almost the whole of the text in the ninth annual report of his survey of the territories, and as a separate pamphlet of 150 pages, with considerable additions by the author. One of the most interesting of these consists in the publication of a letter from Mr. J. W. Cunningham, of Howard County, Nebraska, on the domestication of this species. It appears that the bison has been crossed with the ordinary milch cow, and that half- and quarter-breds are not uncommon, and the cows yield extremely rich milk. They prove to be both hardy and tame. The colour of the bison and the majority of the distinguishing characters disappear after repeated crossings. The lump of flesh covering the dorsal vertebræ also becomes diminished. The preservation of a pure domestic breed of the bison does not seem so easy. In some instances where buffaloes have been broken to the yoke they have proved strong and serviceable, but rather unmanageable at times. Unless the breed is maintained in some way artificially, the wild species will no doubt before very long become extinct.

PRODUCTS OF ASSIMILATION IN MUSACEÆ.—Herr Emil Godlewski has recently investigated whether in the case of Musaceæ the first assimilation-product is oil or starch, which latter is the first product in most plants. Sig. Briosi had recently maintained that oil was first produced. The question which had to be solved, therefore, was whether these plants, when decomposing carbonic acid under the influence of light, exhale a volume of oxygen greater than that of the carbonic acid decomposed. If oil is formed from the carbonic acid this must be the case. Measurements which Herr Godlewski made to this end with *Musa sapientium*, gave negative results; the oxygen exhaled was not of greater volume than the carbonic acid decomposed. Sig. Briosi had failed to discover starch in the grains of chlorophyll of the mesophyll-cells of the leaves; while Herr Godlewski was perfectly successful also in this direction, perceiving numerous granules of starch in leaves from young specimens of species of both *Musa* and *Strelitzia*, which had been collected in the evening after a hot day.

FERTILISATION IN THYME AND MARJORAM.—Under the title of "Das Variiren der Grösse gefärbten Blüthenhüllen, und seine Wirkung auf die Naturzüchtung der Blumen," Dr. Hermann Müller reprints from *Kosmos* a paper containing many of the facts which have appeared from time to time with his signature in these columns. The special point to which he calls attention is the occurrence in many species of Labiatæ—*Thymus serpyllum*, *Origanum vulgare*, &c.—of two distinct forms, one with larger hermaphrodite protandrous, the other with smaller female flowers. The second of these two forms can manifestly only be fertilised by the former, and will disappear where the conditions of life are unfavourable; while the propagation of the first form is in no way dependent on the other.

A FOSSIL FUNGUS.—One of the most interesting recent discoveries in palæophytology has recently been made by Mr. Worthington Smith, in the detection, in the coal-measures, of a fossil fungus nearly allied to that which produces the potato blight, and which he has named *Peronosporites antiquarius*. Fossil fungi were not previously altogether unknown. Some years ago Mr. Carruthers, the keeper of the botanical department at the British Museum, detected mycelial threads among the cells of a fossil fern (*Osmunda*) from the Lower Eocene strata of Herne Bay; and Mr. Darwin has stated that fungus threads in a fossil state in silicified wood were shown to him more than forty years ago by the late Mr. Robert Brown. Messrs. Hancock and Atthey have also described in the *Annals and Magazine of Natural History* (4th ser. vol. iv. 1869, p. 121, t. ix. x.), under the name of *Archagaricon*, what may be a fossil *Peronosporites* from the Cramlington black shale. The specimen examined by Mr. Worthington Smith (the fungoid nature of the organism having been first suggested by Mr. Carruthers), was seen within the vascular axis of a *Lepidodendron*,

and is thus described by that gentleman :—It consists of a mass of mycelia and zoosporangia (or oogonia). Beginning with the mycelium, a close examination shows that it is furnished with numerous joints or septa. If, therefore, any reliance is to be placed upon the modern distinguishing characters of the now living species of the genera *Peronospora* and *Pythium*, as furnished by a septate or non-septate mycelium, the fossil parasite belongs to the former, and not to the latter genus, nor to any of the Saprolegnieæ. The oogonia do not agree with those of *Cystopus*. Within many of the fossil oogonia the differentiation of the protoplasm into zoospores is clearly seen ; but if any doubt could exist as to the exact nature of this differentiation, then other oogonia (or zoosporangia) on the same slide show the contained zoospores with a clearness not to be exceeded by any living specimens of the present time. It is a very remarkable fact that the oogonium precisely resembles, in size and other characters, average oogonia of the present day, especially those belonging to *Peronospora infestans*. The contained zoospores are, moreover, the same in form and dimensions with those of *P. infestans* when measured to the ten-thousandth of an inch. The organisms are, in fact, apparently identical ; and the average number of zoospores in each oogonium is also the same, viz., seven or eight. The aërial condition of the fungus has not yet been observed. Mr. Worthington Smith suggests, in conclusion, that we probably have, in *Peronosporites antiquarius*, one of the primordial plants from which both the great families of fungi and algæ may possibly have descended ; but should not this primordial plant have led a non-parasitic life?—for if parasitical, then this fact points to some pre-existing plant.

THE LAWS OF DIGITAL REDUCTION.—Hitherto there has been little explanation of the curious variation in the number and relative size of the digits in the vertebrata. Mr. John A. Ryder (*American Naturalist*, October) suggests that the number of toes is least where the mechanical strains are greatest, and impacts most frequent and severe. He quotes several cases in which the hinder digits are reduced more than those of the fore feet, and shows that in all of them the body in jumping or running pitches mainly upon the hind limbs. He looks upon the outer toes of man as in process of undergoing reduction, being now weaker and shorter than in any of the higher apes. The chrysochloris among moles is an instance of special reduction in the anterior extremity, and here the mechanical strains are most frequent and severe. Among fossorial animals the claws and toes are usually best developed on the fore limbs. The retention by certain groups, of digits in a very equal state of development in manus or pes, or both, is attributed to the equal distribution of strains on all.

THE BIRDS OF GUADALOUPE ISLAND.—This interesting fauna is dealt with by Mr. Robert Ridgway in the *Bulletin* of the Nuttall Ornithological Club for July. It is strange that only eight forms from this island, situated about 220 miles south-west of San Diego, are satisfactorily known, and their affinities are almost entirely with those of western North America. They are recognised by Mr. Ridgway, however, as specifically distinct, differing from their nearest mainland allies in the (1) increased size of the bill and feet, (2) shorter wings and tail, and (3) darker colours.

THE DISTRIBUTION OF FRESHWATER FISHES.—Dr. D. S. Jordan, the well-known American ichthyologist, has contributed to the *American Naturalist* for October some of his conclusions derived from long study of the fishes of rivers flowing in different directions, and under the most widely-varied physical conditions. He finds that in the case of rivers flowing into the ocean, the character of the fishes of the upper waters bears little or no relation to the place of discharge. The higher or the older the watershed between two rivers, the fewer species are common to both. Certain species (not including species of general distribution) occur on opposite sides of even the highest watersheds. When the watershed between two rivers is a swampy district, the same species are found in the head waters of both, though the faunas of the lower courses may be distinct. There is often a great difference between the forms in the upper and lower waters of a river, owing to differences in physical conditions. Some species are strictly confined to one river basin ; others are widely distributed. Usually the more southern rivers have the most peculiar and varied faunas. Species of the widest distribution often have breaks in their range which cannot be accounted for by any known facts. The characteristically American forms of freshwater fishes are, generally speaking, absent or rare in the waters of New England and of the Pacific slope. The larger the river-basin, the greater its variety of forms. Seventy species have been taken in the little White River at Indianopolis, representing forty-eight genera, twice as many as occur in all the rivers of New England. Other things being equal, a river whose course lies in a region of undisturbed stratified rocks, or of glacial drift, contains most genera and species. Certain forms appear generally distributed in a definite range, either without regard to the direction in which the rivers flow, or even bounded by parallels of latitude. In any river-basin the most abundant species (of small fishes) are usually (1) those peculiar to it, or (2) those of widest distribution.

EARWIGS (FORFICULIDÆ).—Linnæus seems to have known but two species of earwigs (*Forficula auriculata* and *minor*). Both were European, and had *Elytra dimidiata et Alæ tectæ*, and were placed among the beetles (Coleoptera). There are now about 250 species known which are found all over the world, and grouped in about thirty genera, of which the genus Forficula is by far the richest in species and the widest in its geographical distribution. Happily, too, it still retains the two first-named species, and it has also most justly given its name to the family. Entomologists will be glad to know that Mr. Samuel Scudder has just published a series of critical and historical notes on this family, in which he gives descriptions of all the known genera, and an alphabetical list with full synonyms of all the described species ; this most valuable list will make the study of these interesting insects an easy one. It is published in Parts 3 and 4 of vol xviii. of the *Proceedings* of the Boston Society of Natural History.

HUNGARIAN SPIDERS.—The first part of a work on Hungarian Spiders by Assistant-Director Otto Hermann, of Buda Pest, has just reached us. It forms a handsome royal-quarto volume, with three plates, and is printed in double columns, one in Magyar, and the other, fortunately for us, in German. This volume forms part of the *Transactions* of the Royal Hungarian Natural History Society, which is really to be congratulated on the appearance of this and the next work that we will mention. The present volume gives a sketch of the literature belonging to spiders, and forms one of the most generally interesting portions of the work, for it is most carefully elaborated, being divided into the bibliography of the older and the newer times. It further treats of the life-history of spiders in general, and of the geographical distribution of those species to be met with in Hungary. The next volume will contain the spiders met with in Hungary proper.

HUNGARIAN ROTIFERS OR WHEEL-ANIMALCULES.—A memoir on Hungarian Rotifers by Dr. Bartsch Samu is also published under the auspices of the Royal Hungarian Natural History Society, but it is written exclusively in Magyar, if we may except a short appendix containing brief descriptions of the new species determined by the author, and therefore unfortunately we can do no more than call attention to it.

OUR ASTRONOMICAL COLUMN

THE SATELLITES.—The following table presents at one view the mean distances of the satellites from their primaries, expressed in equatorial semi-diameters of the latter, and founded upon the most reliable data hitherto available :—

	The Earth.	Mars.	Jupiter.	Saturn.	Uranus.	Neptune.
I.	60·27	2·72	5·70	2·98	7·71	14·55
II.	—	6·81	9·07	3·83	10·75	—
III.	—	—	14·46	4·75	17·63	—
IV.	—	—	25·44	6·08	23·57	—
V.	—	—	—	8·47	—	—
VI.	—	—	—	19·67	—	—
VII.	—	—	—	24·80	—	—
VIII.	—	—	—	57·28	—	—

It will be seen that the outer satellite of Saturn, Iapetus, is the only one revolving round its primary at a distance similar to that of our moon, with respect to the semi-diameter of the central body. The exterior satellites of Jupiter and Uranus are similarly placed in this respect, and as regards the former planet the reader will remember a suggestion of Sir John Herschel's, that a distant satellite, by which was intended one situate more nearly, as our moon or the Saturnian satellite Iapetus, might be "worth a search." At the end of the last century it was thought that if satellites of Mars existed they might be "distant many degrees from the principal planet," upon which idea the late Prof. D'Arrest argued that a search after a satellite situate many degrees from Mars would be an almost endless task; and further, that a satellite at a maximum digression of seventy minutes of arc would have a sidereal period greater than the synodical revolution of the primary. The same astronomer endeavoured to ascertain, at the opposition of 1864, to what magnitude stars were visible in the vicinity of Mars with the Copenhagen refractor, which has an aperture of about eleven English inches. He considered that a satellite as bright as the twelfth magnitude could hardly have escaped him, and that objects of a fainter class were only visible in such an instrument at distances of eight or ten minutes, and in the case of Mars opportunities of viewing a satellite in such position would occur comparatively seldom. Perhaps the more prevalent idea respecting possible satellites of Mars, prior to their actual discovery, was that they would be "very small and close to the planet." (Hind, in "Solar System," p. 78.)

TYCHO BRAHE'S STAR OF 1572.—It is to be hoped that the vicinity of the famous star in Cassiopeia, with which we are accustomed to associate Tycho Brahe's name, may continue to receive frequent attention, and in particular that the small star, which at present is so near to the most accurate position we are able to obtain of the star of 1572, may be assiduously watched and its brightness determined from time to time by comparison with its neighbours, and not merely by estimation of magnitude. It was Bessel who, as he states in a letter to Olbers, in 1824, first engaged Argelander to work up the position of the Nova Cassiopeiæ, with all possible precision. Forty years later Argelander revised his calculations with improved positions for the reference-stars, and obtained a result differing in no material degree from the earlier one. The small star alluded to is so near to Argelander's last position (differing only fifty seconds of arc), as to be within its possible limits of error; it is No. 129 of the catalogue of stars in the vicinity which was presented to the Copenhagen Academy in January, 1864, and an eleventh magnitude on Bessel's scale. It will be most readily identified by means of the star of the ninth magnitude, No. 300 of Oeltzen's Catalogue from Argelander's northern zones, the position of which for 1878·0 is in R.A. oh. 17m. 32s., N.P.D. 26° 22′·6; the suspicious object follows Argelander's star 29·6s., and is south of it 10′ 4″. The place of Nova for 1878·0 is in R.A. oh. 18m. 2·1s., N.P.D. 26° 31′ 43″.

THE AUSTRIAN COMET-MEDAL.—We have received from the Imperial Academy of Sciences at Vienna, the conditions upon which that body has resolved to renew, until further notice, the prizes for the discovery of telescopic comets, and which appear to be similar to those originally issued in June, 1872. The awarding of a prize, which will consist, according to the wish of the receiver, in a gold medal or its money value of twenty Austrian ducats, is connected with the following conditions: (1) Prizes will be awarded only for the first *eight* successful discoveries in each calendar-year, for comets that at the time of their discovery were telescopic, *i.e.* invisible to the naked eye, that had not been previously seen by any other observer, and which could not have been predicted, and it is important to observe that in the case of independent discoveries priority is to be decided by the epoch of the first position. (2) The discovery must be communicated to the Academy of Sciences immediately, by telegraph, where practicable, otherwise by the earliest mail, the Academy undertaking to make it known without delay to several observatories. (3) This first notice must necessarily contain the position and motion of the comet as accurately as they are known, with the place and time of discovery, and is to be supplemented at the next opportunity by later observations. (4) If the discovery should not have been verified by other observers, the prize will only be adjudged "when the observations of the discoverer are sufficient for determining the orbit." (5) The prizes will be awarded in the general sitting of the Academy held at the end of May in each year, and in cases where the first intimation of the discovery arrives between March 1 and May 31, the award will be decided in the general May session in the following year. (6) Application must be made for the prize to the Imperial Academy within three months after the first notice of discovery shall have reached it, later applications being rejected. Finally, the astronomers of the observatory of the University of Vienna are appointed judges, whether the conditions in (1), (3), and (4) have been fulfilled.

GEOLOGICAL WORK OF THE U.S. SURVEY UNDER PROF. HAYDEN DURING THE SUMMER OF 1877

THE necessity of a careful examination of the various geological formations in the field, and a review by a practical palæontologist of the various districts that have from year to year been surveyed by the different geologists of this and other surveys, has been long felt. Such a work, indeed, was imperatively necessary, before a consistent and comprehensive classification of the formations could be established. This duty was assigned to Dr. C. A. White, the palæontologist of this survey, and he took the field at the beginning of the past season and continued his labours until its close. The special duty with which he was charged was to pursue such lines of travel as would enable him to make critical examination of the geological formations in succession as they are exposed to view on both sides of the Rocky Mountain chain, and also on both sides of the Uinta chain; to collect and study the fossils of these formations in such detail as to settle, as far as possible, the questions of the natural and proper vertical limits of the formations, their geographical range, their correlation with each other, and to define the palæontological characteristics of each.

He has pursued his researches with such success during the past season as to demonstrate the necessity of continuing this class of investigations by various lines of travel across what is generally known as the great Rocky Mountain region, especially those portions of it that have

been surveyed, as well as those in which surveys are in progress.

Among other important results, he has shown the identity of the lignitic series of strata east of the Rocky Mountains, in Colorado, with the Fort Union group of the Upper Missouri River, and also its identity with the great Laramic group of the Green River Basin and other portions of the region west of the Rocky Mountains. He also finds the planes of demarcation between any of the mesozoic and cenozoic groups, from the Dakota to the Bridger, inclusive, to be either very obscure or indefinable; showing that whatever catastrophal or secular changes took place elsewhere during all that time, sedimentation was probably continuous in what is now that part of the continent, from the earliest to the latest of the epochs just named.

The general course of travel pursued by Dr. White during the season was as follows, not including the numerous detours, meanderings, and side trips, which the work necessitated. Outfitting at Cheyenne, he journeyed southward, traversing in various directions a portion of the great plain which lies immediately adjacent to the eastern base of the Rocky Mountains in Colorado. The most easterly point thus reached was some sixty miles east of the base of the mountains, and the most southerly point, about twenty-five miles south of Denver. Returning to Denver to renew his outfit, he crossed the Rocky Mountains by way of Boulder Pass, through Middle Park. After making certain comparative examinations of the mesozoic and cenozoic formations in Middle Park, he proceeded westward to the head-waters of Yampa River, following that stream down to the western foothills of the Park Range of mountains. Here, resuming his comparative examination of the mesozoic and cenozoic strata, he passed down the Valley of the Yampa as far as Yampa Mountain, one of those peculiar and remarkable upthrusts of palæozoic rocks through mesozoic strata. In all this area, as well as that between the Yampa and White Rivers, the Laramic group reaches a very great and characteristic development; and it received careful investigation, yielding some of the most important results of the season's work. Crossing the ground between the two rivers named, to White River Indian Agency; thence down White River Valley about 100 miles, thence to Green River, crossing it at the southern base of the Uinta Mountains, making many detours on the way, he reviewed the geology of the region which he had surveyed during the previous season. This review brought out not only the important palæontological facts before referred to but it also added materially to the elucidation of the geological structure of the region which lies between the eastern end of the Uinta mountain range on the west, and the Park range on the east.

Beyond Green River he pursued his travels westward, studying the mesozoic and cenozoic strata that flank the Uinta range upon its south side, and making comparisons of both their lithological and palæontological characteristics.

In this way he traversed the whole length of the Uinta range, crossing at its junction with the Wasatch range over into the valley of Great Salt Lake. Re-crossing the Wasatch to the north side of the Uinta range, he continued his examinations of the cretaceous and tertiary strata into and entirely across the Great Green River basin, leaving the field at the close of the season at Rawlin's station on the Union Pacific Railroad.

A general statement of the results of the season's work has been given in a previous paragraph, but the following additional summary will make the statement somewhat clearer, being made after the route of the season's travel has been indicated. The formations of later mesozoic and earlier cenozoic ages, especially those to which Dr. White, in former publications, has applied the provisional designation of "post-cretaceous," have received particular attention. The extensive explorations of Dr. Hayden in former years, and the palæontological investigations of the late Mr. Meek, pointed strongly to the equivalency of the Fort Union beds of the Upper Missouri River with the lignitic formation as it exists along the base of the Rocky Mountains in Colorado; and also to the equivalency of the latter, with the Bitter Creek series west of the Rocky Mountains. The investigations of the year have fully confirmed these views by the discovery not merely of one or two doubtful species common to the strata of each of these regions, but by an identical molluscan fauna ranging through the whole series, in each of the regions named. This shows that the strata just referred to all belong to one well marked period of geological time; to the strata of which Mr. King has applied the name of "Laramic group" (Point of Rocks, Group of Powell). His investigations also show that the strata which in former reports by himself and Prof. Powell, have been referred to the base of the Wasatch group, also belong to the Laramic group, and not to the Wasatch. He has reached this later conclusion not merely because there is a similarity of type in the fossils obtained from the various strata of the Laramic group with those that were before in question; but by the specific identity of many fossils that range from the base of the Laramic group up, into, and through the strata that were formerly referred to the base of the Wasatch. Furthermore some of these species are found in the Laramic strata on both sides of the Rocky Mountains. Thus the vertical range of some of these species is no less than three thousand feet and their present known geographical range more than a thousand miles.

Besides the recognition of the unity of the widely distributed members of the formation of this great geological period, bounded by those of undoubted cretaceous age below, and those of equally undoubted tertiary age above; his further observations have left comparatively little doubt that the "lake beds" of Dr. Hayden, as seen in Middle Park, the "Brown's Park group" of Prof. Powell, and the "Uinta group" of Mr. King, all belong to one and the same epoch, later than, and distinctly separate from, the Bridger groups. In that portion of the region which lies adjacent to the southern base of the Uinta mountain range, and which is traversed by Lake Fork and the Du Chesne River, not only the Uinta group, but both the Green River and Bridger groups also, are well developed, each possessing all its peculiar and usual characteristics, as seen at the typical localities in the great Green River Basin, north of the Uinta Mountains. This, added to the known existence of Bridger strata in White River Valley, and the extensive area occupied by the Green River group between White and Grand Rivers, has added very largely to our knowledge of the southward extension of those formations.

In all the comparative examinations of the formations or groups of strata that have just been indicated he has paid special attention to their boundaries or planes of demarcation, crossing and recrossing them wherever opportunity offered, noting carefully every change of both lithological and palæontological characters. While he has been able to recognise with satisfactory clearness the three principal groups of cretaceous strata, namely, the Dakota, Colorado, and Fox Hills, on both sides of the Rocky and Uinta Mountains respectively, they evidently constitute an unbroken series so far as their origin by continuous sedimentation is concerned. While each of the groups possesses its own peculiar palæontological characteristics, it is also true that certain species pass beyond the recognised boundaries of each within the series.

The stratigraphical plane of demarcation between the Fox Hills, the uppermost of the undoubted cretaceous groups, and the Laramic group, the so-called post-cretaceous, is equally obscure; but the two groups are palæon-

tologically very distinct, inasmuch as the former is of marine origin, while the latter, so far as is now known, contains only brackish-water and fresh-water invertebrate forms. He reports a similar obscurity or absence of a stratigraphical plane of demarcation between the Laramie and Wasatch groups, although it is there that the final change from brackish to entirely fresh waters took place over that great region. Furthermore, he finds that while the three principal groups of the fresh-water tertiary series, west of the Rocky Mountains, namely, the Wasatch, Green River, and Bridger groups, have each peculiar characteristics, and are recognisable with satisfactory distinctness as general divisions, they really constitute a continuous series of strata, not separated by sharply-defined planes of demarcation, either stratigraphical or palæontological.

During the progress of the field work, as above indicated, large and very valuable collections of fossils have been made, all of which will constitute standards of reference in the future progress of the work, and quite a large number of the species are new to science. These are now being investigated, and will be published in the usual palæontological reports of the survey.

NOTES

AT the moment of going to press we have received the report of the *Inflexible* Committee. The impression a first glance over it gives is that the *Inflexible* is a passable ship, but that the Committee strongly urge the Admiralty not to proceed with any more like it, which practically puts an end, we presume, to the *Ajax* and *Agamemnon*, in their present form, as well as to the fourth ship which the Admiralty proposed to build. It is proper, however, to state that a closer perusal of the report shows the *Inflexible* herself to be open to the gravest objections in several respects, and that the Committee recommend considerable modifications in her. In our next number we shall fully review the report.

WE have received several letters from India, showing that great interest is being taken in that country with reference to the best methods of determining the amount and variation of solar radiation. We may state that both Prof. Stewart and Mr. Lockyer have recently devised instruments to secure these data. The latter proposes to utilise Capt. Abney's method of obtaining photographs of the red end of the spectrum, so that variations in thermal and chemical intensity may both be recorded automatically.

SIR WILLIAM THOMSON has been elected a Foreign Associate of the Paris Academy of Sciences, to fill the place vacated by the death of von Baer.

PROF. SIR WYVILLE THOMSON has been created a Knight of the Royal Order of the Polar Star by the King of Sweden.

M. TEMPEL is to continue henceforth the publication of Donati's *Bollettino* of the Arcetri Observatory, of which only one number had been issued when Mr. Donati died.

GEN. NANSOUTY, Director of the Observatory situated on the top of the Pic du Midi has been nominated "Officier de l'Université" by M. Faye, the new Minister of Public Instruction. The General, as our readers know, spends his winters on that precipitous mountain for meteorological observations. We are glad to register such an acknowledgment of his devotion to science.

DR. BURDON-SANDERSON gives notice that the first of his annual course of lectures on comparative pathology will be delivered at the University of London, Burlington Gardens, on Saturday, December 15, at half-past five o'clock. The subject of the lecture will be, "The Infective Processes of Disease." The succeeding lectures will be on the Monday, Wednesday, and Friday of the following week, at the same hour, for which days "The Nature and Causes of Septic Infection," "The Germ Theory," and "The Theory of Contagium Vivum," are among the topics to be discussed.

THE German postal department has issued a complete series of regulations for the use of the telephone in the various offices where it has been established. In § 15 we notice the rule that the speaker shall pronounce each syllable slowly and separately, and make a pause at the end of every six words to give time for the receipt of the message. The receiver repeats the whole message at the end at an ordinary rate of delivery. Proper names and foreign messages are spelled. The Postmaster-General, Dr. Stephan, who wages an unmerciful war in his department against all foreign words where a German equivalent is possible, has christened the new invention as the *Fernsprecher* (far-speaker), and excluded entirely the Greek *telephone* from his regulations.

IN consequence of the large numbers who were unable to obtain admission to the recent lecture at the Society of Arts on the "Telephone," Prof. Bell, at the special request of the Council of the Society, has consented to repeat his lecture on Wednesday, the 19th inst. As there is certain to be a large attendance, it is suggested that those members who heard the first lecture, should refrain from exercising their privilege of being present on the second occasion.

PROF. KEKULÉ, of Bonn, the originator of the present benzene theory has been nominated for president of the German Chemical Society for the coming year. The policy which the society adopted at its last annual election of choosing its chief officer from among the leading German chemists at a distance from the headquarters of the society, seems to meet general favour, and Prof. Wöhler, the Nestor of organic chemistry, will certainly be ably succeeded by Prof. Kekulé, whose classical researches and theoretical deductions form the basis of the present atomistic theory. The German Chemical Society would do well to copy one of the customs of its sister society in London, viz., to require an inaugural address from its newly-elected presidents. We notice that the library of the society will be enriched by the bequest of the extensive chemical library of the late Prof. Oppenheim, an accession which will double the present number of volumes.

DR. VOHL, of Cologne, has adopted an ingenious method of determining the impurities in the Rhine, which consists in analysing the boiler incrustations of the river steamers, as well as the concentrated residues remaining in the boilers after passing over a certain distance. By this means he has detected the presence of a large amount of arsenious acid in the river water—resulting chiefly from the aniline and dyeing establishments—as well as other poisonous substances. An unusually high percentage of phosphoric acid showed that the sea was daily absorbing vast quantities of the most valuable fertilising material from the soil of Germany.

THE Scientific Congress of France will meet at Nice from January 10 to 20, 1878. The locality is likely to attract many visitors at such a cold period of the year.

ANOTHER sitting of the enlarged Council of the Observatory of Paris was held on December 9. The councillors passed a resolution for an increase of the salary of the astronomers and auxiliary astronomers, the maximum pay of the former to be 10,000 francs instead of 8,000, and of the second 7,000 instead of 6,000. They propose to the Government to place the appointment of the director of the establishment partly in the hands of the Academy of Sciences and partly in the hands of the Council, the Minister to have only the privilege to choose

between both presentations. It should be remembered that under the former organisation the appointment of the director was in the hands of the Bureau des Longitudes, which had to designate yearly their member to preside over the observations. Arago and his illustrious predecessor held their office by a yearly tenure, renewed up to the time of their death. It was only Leverrier who was appointed by the Government; under the old monarchy the director was appointed by the king. A proposal was made for suppressing the general assembly of astronomers, which was established by M. Leverrier, and is to be held at Easter at the Ministry of Public Instruction. The proposal was out-voted. At the next sitting the long-discussed organisation of meteorology will be introduced; the existing order of things continues to enjoy the support of the majority.

A TELEGRAM from Alexandria states that Capt. Burton has started from Suez for Moilah on a second expedition to Midia, accompanied by many Europeans and a large number of native workmen and troops. A dépôt will be formed at Moilah in the Gulf of Akaba, and the expedition will extend to the second range of mountains hitherto unexplored. Capt. Burton expects to discover a rich mineral country between the two ranges of mountains. He will be absent four months.

THE Montsouris Park, in the centre of which the Montsouris Observatory has been erected, is almost ready for public use. Admittance to the observatory grounds will be procured on application to the secretary, for the purpose of inspecting the instruments and the working of the meteorological observations.

IN Würtemberg a remarkable property of ripe grapes has been recently discovered, which the agricultural authorities have now published, so that all proprietors of vineyards may derive benefit from being acquainted with it. It appears that if ripe grapes, which have become frost-bitten, are kept for a little time in some dry place, they entirely lose the bad effects caused by the frost.

IN the *Bulletin* of the French Geographical Society for October are some interesting notes from the Abbé Desgodins, on Tibet. The Abbé gives some information concerning the Brahmapootra, which he obtained from an old lama, whom he believes to be thoroughly trustworthy. This lama has travelled much, and visited nearly the whole of Tibet. His information goes to prove the identity of the Yar-tsiou-tsang-po with the Brahmapootra. He has followed the great river from its source in or near the lakes of Tso-ma-pang in the west of the province of Ngaré, the most western of Tibet, and in making his pilgrimages he has reached the frontiers of the savage tribe of the Lhopa. The lama states that some days to the east of Lassa the river turns towards the south, making a great bend, and traverses the well-peopled and rich district of Hia-zul, just to the north of the Lhopa. Passing through the latter district, it flows among steep and rugged rocks, and after a certain distance forms a great waterfall. This fall of the Yar-kiou-tsang-po, M. Desgodins has no doubt, is identical with the fall of Brama-Khoond, well known to the Assamese. The lama affirmed that the river did not reach so far as the Nahengs (Mishmis), but that it disappeared more to the west, among the Lhopa. The lama gave the Abbé, besides, much information concerning the people and the districts through which the river passes. The *Bulletin* contains, besides, a learned article by M. E. Cortambert on some of the geographical monuments of the middle ages in the National Library, dwelling at considerable length on the well-known Mappemonde of Beatus, a beautiful facsimile of which is given.

THE Italian Geographical Society has received letters from Aden dated November 25, which confirm the arrival of the second Italian (Martini-Cecchi) expedition at Farré. There is no news at all about the supposed defeat of King Menelik of Schoa in connection with which the death of the Marquis Antinori was reported. It seems, however, that King Kassa gained a victory over a Prince Menelik (son of the late King Theodor), who had rebelled in Kassa's camp. The resemblance of names explains the misunderstanding and deprives of any foundation the news about the misfortune said to have happened to the members of the first Italian (Antinori) expedition.

THE French Acclimatisation Society held its anniversary meeting on December 7 last, under the presidency of M. Quatrefages. The Society lost recently M. Drouyn de Lhuys, one of its founders, a former minister of the empire, well known in France as well as abroad.

IN this month's *Geographical Magazine* Mr. C. R. Markham continues his valuable papers on Irrigation in Southern India, and Mr. G. J. Morrison concludes his interesting description of the island of Formosa. In criticising Mr. Trelawney Saunders on the question of "Water-partings *versus* Ranges," Mr. R. B. Shaw appears to have misconceived Mr. Saunders' statements; Mr. Saunders' knowledge is too extensive and accurate to allow him to maintain the identity of the two terms. Sir George Nares contributes an important article on the Greenland Foehn, recently noticed in NATURE.

WE are glad to learn from the *Geographical Magazine* that the Dutch are making active preparations to resume Arctic exploration, to which they have been able to do little since the days of the brave but unfortunate Barentz, and nothing at all, we believe, during the last century. A new schooner is to be built to be sent out in May next year to make a summer cruise in the Spitzbergen and Barentz Seas.

THE hygrometer devised by M. Alluard, described in NATURE, vol. xvii. p. 14, was constructed by M. L. Golaz, of 24, Rue des Fosses St. Jacques, Paris, who contributed some beautifully-constructed apparatus to the recent Loan Collection at South Kensington.

DR. SCHLIEMANN, assisted by Mr. Streatfield, of the Science and Art Department, is busy arranging his Trojan treasures in the South Kensington Museum. Although a large space has been assigned for their reception, it will take considerable ingenuity to get all the interesting articles satisfactorily arranged.

M. DAHLANDER communicates to the Swedish Academy of Sciences the results of his observations on the comparative rapidity with which heated solid bodies are cooled by immersion in various liquids. If the cooling power of water be taken as unity, that of alcohol is 0·58, of mercury 2·07, of a concentrated solution of salt, 1·05, and of a concentrated solution of sulphate of copper, 1·03. The rapidity of the cooling increases with the increased temperature of the liquid.

THE twenty-first annual report of the committee of the Free Public Libraries and Museums of Sheffield, speaks favourably of the progress of these institutions. We are glad to see that the number of scientific works sought for both in the lending and consulting libraries bears a fair proportion to the number in other departments.

ACCORDING to the published reports of the Koenigsberg Board of Trade, the total production of amber in the province of Prussia amounted to 135 tons during the year 1876, of which eighty-five tons were furnished by one mine alone, viz., the mine of Palmnicken. This production considerably exceeded that of the previous year. The amber was exported principally to Austria, France, Russia, America, China, and Japan, while the export to India, Persia, and Australia does not pay the producers, and is therefore extremely limited. The number of workmen in the province who are employed in the production of amber amounts to nearly 1,400.

NOW that the struggle in the East seems to be reaching its crisis, the fine, large, clear map of the Bosphorus and the

Dardanelles, just published by Mr. Stanford, will be extremely useful to those who desire to follow, with intelligence, further movements, military or diplomatic.

MR. HEIGHWAY'S handbook of "Practical Portrait Photography" (London, Piper and Carter), has reached a second edition, into which some improvements have been introduced.

THE death is announced of Mr. John G. Anthony, who for some years has had charge of the conchological department of the Cambridge Museum. He was one of the party accompanying Prof. Agassiz in his celebrated scientific expedition to Brazil.

THE number of French communes receiving the daily warnings of the international service for agricultural purposes is increasing daily; the death of Leverrier has not destroyed that extraordinary movement. It is said the twenty districts into which Paris has been divided, will very soon have the daily warnings posted at each of their respective mairies. According to a saying attributed to M. Dumas, "The existing meteorology had had its own plebiscitum."

PROF. J. PLATEAU, of Ghent, has reprinted (from the *Proceedings* of the French Association for the Advancement of Science, 1876) a paper on the question, Is the instinct of insects deceived by artificial flowers? As far as the series of experiments performed by him—rather few in number, but apparently carried out with great care—can be relied on, although insects may be attracted from a distance by the bright colours of artificial flowers, they are never tempted by the resemblance to alight on them in the hope of obtaining food from them. He concludes, therefore, that insects make use of some other organ than that of sight in the selection of the flowers which they visit.

PROF. E. MORREN, of Liége, has issued the fifth annual edition of his "Correspondance Botanique," which contains a complete list of botanical gardens and museums, and the occupants of botanical chairs throughout the world. Even adding a number of "unattached" English botanists whose names are given, it is instructive to compare the number engaged in botanical research in Great Britain with that in France or Germany, or even in Italy or Russia.

A BRIEF report of the third annual conference of the Cryptogamic Society of Scotland, held at Dunkeld in October last, has been published, from which it is evident the meeting was successful. The first fasciculus of the "Fungi Scotici Exsiccati" will be published in January. Dr. Buchanan White, Perth, will receive orders; no subscribers names can be received after the 20th inst.

WE have received Part 2, 1876–77, of the *Transactions* of the Cumberland Association of Literature and Science, which contains a number of scientific papers of considerable value. Among these are six original papers communicated to the societ connected with the Association during the session, and selected by the Council for publication. Two of these will interest the scientific reader: "Jonathan Otley, the Geologist and Guide," by Mr. Clifton Ward, and "Notes on the Migratory Birds of the English Lake District," by Mr. John Birkett.

THE seventh annual report of the Leeds Naturalists' Club and Scientific Association speaks in the most favourable terms of the continued progress of that society.

IN the *Monatsbericht* of the Prussian Academy of Sciences for July, which has just appeared, we notice papers by H. Anver-, "On the Results of the Transit Observations with Bradley's Quadrant;" by H. Websky, "On the Horn-Mercury from el Doctor in Mexico;" by Prof. du Bois Reymond, Prof. Peters, and Prof. Möbius, "On the Amphibious Collections made by Dr. Sachs during his late trip to Venezuela."

IN the *Atti della Reale Academia dei Lincei* at Rome, some interesting investigations are described, which were made by Messrs. A. and G. De Negri at the Chemical Laboratory of the Genoa University, on the purple dies of antiquity. The authors have thoroughly investigated the subject; after an elaborate account and an enumeration of the various historical data with regard to the molluscs from which the ancients obtained their purple colours, they enter into a discussion of the chemical and optical properties of these substances, the methods of dyeing with them, the adulterations found in them, and various other details concerning them. We must refer our readers to the original treatise for further particulars, as our space will not permit us to enter into them. The paper is accompanied by a number of plates, giving the spectra of the colours obtained from species of the genera *Applysia* and *Murex*. The same volume of this publication contains an excellent account, by Signor C. Bagnis, of the fungi species *Puccinia*, illustrated by no less than eleven well-drawn plates.

THE Piscicultural Institution of Schwerin has recently made some important experiments with a view to ascertain whether the artificial culture of river Crawfish (*Astacus fluviatilis*) is possible on a large scale. The experiments were entirely successful. In the spring of last year some 700 crawfish with ova were placed into two circular ponds of only six feet diameter, and for each animal a separate hole had been constructed. At the end of November the ponds were drained in order to separate the young crawfish from the old ones. It appeared that of the latter only three or four were crawling about at the bottom of the pond while all the others had occupied their respective dwellings. The young were of the size of a bee and extremely lively; they were taken out of the ponds and already on the following day could be fed artificially with carrots and meat. Many a land or garden proprietor could thus make crawfish-culture a lucrative pastime at very little cost, particularly since the consumption of these crustaceans increases largely every year.

THE last number of the *Zeitschrift für Ethnologie* contains a most valuable and elaborate review of the entire ethnological and anthropological literature of 1876, prepared by Prof. W. Koner. Over 1,000 pamphlets, periodicals, and books are referred to, and as few subjects are handled in a greater variety of languages than those in question, the labour of compiling such a report can easily be imagined.

WE have received the third (final) part of Herr Axel Blytt's elaborate Flora of Norway, which is published by order of the Royal Norwegian Society of Sciences, and bears the title, "Norges Flora; eller Beskrivelser af de i Norge vildtvoxende Karplanter" ("Flora of Norway; or, Description of the Wild Plants in Norway.")

A CORRESPONDENT asks where he can find a description of the mode of drying sections of trees. He has a transverse section, three inches thick, of an elm tree, and he wants to dry it so that it may be cut in veneer when ready.

THE additions to the Zoological Society's Gardens during the past week include a Diana Monkey (*Cercopithecus diana*) from West Africa, presented by Mr. Walter Mayhew; a Rhesus Monkey (*Macacus erythræus*) from India, presented by Mr. R. S. Cox; two White Storks (*Ciconia alba*), a Common Heron (*Ardea cinerea*), a Greater Black-backed Gull (*Larus marinus*), European, presented by Mr. C. Clifton; a Hobby (*Hypotriorchis subbuteo*), captured at sea, presented by Mr. W. Renney; two Lesser Sulphur-crested Cockatoos (*Cacatua sulphurea*) from the Moluccas, presented by Mrs. Roberts; seven Gelada Baboons (*Cynocephalus gelada*) from Abyssinia, four Barbary Turtle-Doves (*Turtur risorius*) from North Africa, deposited; two Schlegel's Doves (*Chalcopelia puella*) from West Africa, purchased.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The examination for open scholarships at Christ's College will be held on Tuesday, April 9. Candidates in natural science will be required to show a satisfactory knowledge of elementary chemistry, both theoretical and practical. Candidates are required to send in their names to one of the tutors of the college before April 2. Further information can be obtained on written application to Mr. John Peile, or the Rev. J. W. Cartmell, Christ's College.

SCIENCE AND ART DEPARTMENT.—The list has been published by the Science and Art Department of the successful candidates in honours at the examination of science schools and classes, May, 1877. We give the names of the two first in the first class of each subject:—Subject I. Practical, Plane, and Solid Geometry—John R. Smith, age 32, clerk; William J. Last, age 19, engineer. Subject II. Machine Construction and Drawing—Robert A. Sloan, age 22, engineer; William Sisson, age 24, engineer. Subject III. Building Construction—Crichton Walker, age 34, carpenter; Robert Henry, age 22, draughtsman. Subject IV. Naval Architecture—Frederick B. Ollis, age 18, shipwright's apprentice; George A. Agnew, age 23, shipwright's apprentice. Subject V. Pure Mathematics, Stages One, Two, and Three—George J. T. Harker, age 18, student; Arthur W. Ward, age 18, cotton broker. Stages Four and Five—Frederick W. Watkin, age 18, pupil; Arthur E. Holme, age 18, engineer. Subject VI. Theoretical Mechanics—William Sisson, age 24, engineer; William Martin, age 22, engineer. Subject VII. Applied Mechanics—Frank W. Dick, age 23, engineer; Fred Ogden, age 18, engineer, William J. Last, age 19, engineer, Robert A. Sloan, age 22, engineer, Robert Greenhalgh, age 22, engineer—eq. Subject VIII. Acoustics, Light, and Heat—Frederick E. Boughton, age 20, draughtsman; James Greer, age 31, Inland Revenue officer. Subject IX. Magnetism and Electricity—Robert A. Sloan, age 22, engineer, Frederick E. Boughton, age 20, draughtsman—eq.; William J. Last, 19, engineer. Subject X. Inorganic Chemistry—Charles N. Luxmore, age 19, chemist's assistant; Sidney E. Meates, age 17, chemical student. Subject XI. Organic Chemistry—Charles M. Luxmore, age 19, chemist's assistant. Subject XX. Navigation—George Goodwin, age 14, engineer's apprentice; William Allingham, age 26, clerk. Subject XXII. Steam—Robert A. Sloan, age 22, engineer, William Sisson, age 24, engineer—eq.; Alfred Cliff, age 22, engineer, Jerdan Nichols, age 21, engineer—eq. Subject XXIII. Physical Geography—John S. Harper, age 19, student in training; John Sharkey, age 29, schoolmaster. Subject XXIII. Physiography—George A. Freeman, age 26, schoolmaster; John A. Lakin, age 21, teacher, Fredk. J. Richardson, age 16, teacher—eq. Subject XXIV. Principles of Agriculture—Edward S. Chesney, age 21, student; William E. Akroyd, age 20, student. There have been no first class successes in Geology, Mineralogy, Animal Physiology, Elementary Botany, General Biology, Principles of Mining, Metallurgy, and Nautical Astronomy.

BRISTOL.—The annual meeting of the governors of University College was held on Friday last, when a report, on the whole satisfactory, was presented. The number of students has somewhat decreased, as indeed might have been expected, but there seems every reason to believe that the college has taken its place as an important centre of education in the west of England. The funds of the college, though considerable in amount, are yet not sufficient to keep it going with complete efficiency, and we hope the appeal made by the governors will be satisfactorily responded to. It is proposed to make the college a local centre for the examinations of the University of London.

PESTH.—A commission has recently been appointed by the various faculties, to make fitting preparations for the celebration of the first centennial of the opening of the university, which was performed by Maria Theresa in 1780. The university is wealthy, possessing property to the amount of 6,000,000 florins, and a library of 120,000 volumes, and forms the real centre of Hungarian intellectual life. The other two Hungarian universities, Klausenberg and Agram, were founded respectively in 1872 and 1874. At present the instructors number 150 and the students 2,630.

WÜRZBURG.—Prof. Sachs has declined the call to the vacant chair of botany at the Berlin University, and the authorities are still seeking a successor for the late Prof. Braun.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, December 6.—Points of resemblance between the suprarenal bodies of the horse and dog, and certain occasional structures in the ovary, by Charles Creighton, M.B., Demonstrator of Anatomy, Cambridge University. Communicated by Prof. Humphry, F.R.S.

On the tides at Malta, by Sir G. B. Airy, K.C.B., Astronomer-Royal.

Observations on hermetically-sealed flasks opened on the Alps, in a letter to Prof. Huxley, Sec. R.S., by Prof. Tyndall, LL.D., F.R.S. Though the author believes the question of "Spontaneous Generation" is practically set at rest for the scientific world, he has been making some experiments on *Bacteria*.

He took with him this year to the Alps sixty hermetically-sealed flasks, containing infusions of beef, mutton, turnip, and cucumber, which had been boiled for five minutes and sealed during ebullition. These were kept for six weeks, when some were opened in a hay-loft and others on the edge of a precipice.

The two groups of flasks were then placed in the author's kitchen, where the temperature varied from about 65° to 90° Fahr. The result was that twenty-one of twenty-three flasks opened in the hay-loft were filled with organism; two of them remained clear. All the flasks opened on the edge of the precipice remained as clear as distilled water. Not one of them gave way.

Chemical Society, December 6.—The President in the chair.—The following papers were read:—On gallium, by W. Odling. The properties of the metal, its chloride, and sulphate, and their reactions, were given and specimens exhibited.—On nitrification, a report of experiments conducted in the Rothamsted Laboratory, by R. Warrington. Schloesing and Müntz have shown that nitrification is due to the action of an organised ferment whose action is suspended by chloroform. The author has completely confirmed the above statement, and has proved that carbolic acid and bisulphide of carbon also stop the action of the ferment, and moreover that darkness is essential for the process. The author has succeeded in converting a dilute solution of ammonium chloride into a nitrate by seeding it with some earth from a fairy ring and keeping it in the dark for three months.—On potable waters, by E. J. Mills, D.Sc. The author investigates the minute errors incidental to the process of Frankland and Armstrong with great care, suggests a new form of evaporator, and arrives at three natural constants or ratios of organic carbon to organic nitrogen in potable waters.—On some derivatives of allylacetone, by J. R. Crow. By the action of sodium, a secondary alcohol homologous with allyl alcohol was prepared; its acetate and dibromide were also investigated.—On a fourth method for estimating bismuth volumetrically, by M. M. P. Muir. The bismuth is precipitated as oxalate, the latter on boiling is converted into a basic oxalate, the precipitate is well washed, dissolved in hydrochloric acid, and the solution titrated with permanganate.—On the gas of the Grotto del Cane, by T. G. Young. This gas contains 61-71 per cent. of carbonic acid, the residual air having the composition oxygen, 20·25, nitrogen, 79·75.—Note on tetrabromide of tin, by T. Carnelly, D.Sc., and L. T. O'Shea. This body was obtained as a colourless liquid, solidifying to a mass of colourless crystals,—melts at 30° C., boils at 201°.

Meteorological Society, November 21.—Mr. H. S. Eaton, M.A., president, in the chair.—The following gentlemen were elected Fellows of the Society, viz.:—E. D. Archibald, B.A., R. W. P. Birch, Capt. W. F. Caborne, H. Clarke, L.R.C.P., Cohen de Lissa, F.S.S., R. Gordon, J. Hunter, jun., J. J. Lake, Rev. E. A. D. O'Gara, O.S.B., R. Pennington, LL.B., E. E. Prichard, and Rev. S. J. W. Sanders.—The following papers were read:—On the general character and principal sources of variation in the weather at any part of a cyclone or anti-cyclone, by the Hon. Ralph Abercromby, F.M.S. In a cyclone the broadest feature of the weather, as seen on a synoptic chart, is an area of rain about the centre surrounded by a ring of cloud, beyond which the sky is clear. The precise form and position of these areas vary with the type of pressure distribution, with the intensity of the cyclone, and with the rate of its progress; they are also influenced by local, diurnal, and seasonal variations, the general sphere of each of which is indicated. By recording the appearance to a single observer of any part of a

cyclone as it passes over him, it is discovered that the area of rain and cloud-ring may be divided into two portions—the front and the rear—differing in physical appearance and general character of the weather by a line drawn through the centre, in front of which the barometer is falling and in rear of which it is rising. Details are given and it is shown that this character remains constant whatever changes the variations above mentioned may effect. In anti-cyclones synoptic charts show great irregularity in the positions of cloud, &c., owing to local, diurnal, and other variations, but to a single observer, who considers the surroundings and physical appearance, a certain general character can be discovered in every part. A marked contrast is shown to exist between the diurnal variation of the weather in a cyclone or anti-cyclone, and a probable connection is pointed out between the diurnal variation of the weather and the diurnal variation of the barometer.—On a remarkable barometric oscillation on January 30, 1876, by Robert H. Scott, F.R.S. At 8 A.M. a remarkable dip appeared in the barometric curve for Armagh. The total amount of reduction of pressure was ·097 inch in 25 minutes and for a portion of the time, from 8·5 to 8·10, the fall was ·058 inch, being at the rate of ·697 inch per hour. On looking to the other barograms, it was found that while a very similar oscillation of slightly greater amplitude, ·102 inch, appeared at Aberdeen at noon, almost exactly four hours subsequent to the occurrence at Armagh, hardly a trace of disturbance could be detected in the barogram for Glasgow, and yet the last-named observatory lies almost on the direct line between Armagh and Aberdeen. The barograms for Stonyhurst and Halifax showed as little disturbance as Glasgow. At Dunecht Observatory the oscillation took place somewhat earlier and exhibited less intensity than at Aberdeen. At Bidston, however, which lies more out of the probable path of the depression than Stonyhurst, the oscillation is seemingly recorded with considerable distinctness. Temperature showed no appreciable change at Armagh, Glasgow, or Aberdeen. At the time of occurrence of the minimum a temporary change of direction and increase of velocity of the wind is recorded both at Armagh and Aberdeen.—The "arched squalls" of the neighbourhood of the trade-winds and of those regions where the monsoons blow with slight force and with interruptions, by Capt. A. Schück.

Physical Society, December 1.—Prof. G. C. Foster, president, in the chair.—Prof. Graham Bell exhibited and described the telephone before a crowded meeting of the Society, prefacing his account of the apparatus now so well known by a very complete historical sketch of the progress of electric telephony. The first experiments referred to were those of Prof. Page, who, in 1837, was studying the relation of electricity to magnetism, and found that if a coil of wire, traversed by a current, surrounds an iron rod, a sound like a pistol shot proceeds from this latter whenever the current is made or broken. He was followed by De la Rive, Poggendorff, Reiss, and others, but Reiss was the first to employ the human voice in his experiments. After pointing out that in transmitting sounds by electrical means the initial sounds themselves are in no sense transmitted but are only employed to generate currents which reproduce similar sounds, Prof. Bell proceeded to examine the phenomena which take place when sounds are transmitted through the air. It is, of course, not the motion of the vocal organs themselves that is received in the ear, but that of the air set in motion by their means, and all peculiarities in the sound must be peculiarities in the motion of that air. If the rapidity of motion varies it occasions a variation in the pitch, and the loudness is changed by changing the amplitude. The *shape* of the vibration produces timbre. If by moving the air in certain specified ways, certain vowel sounds are given out, then those same sounds will be emitted if an identical movement be occasioned by any mechanical means whatever, and Prof. Bell has found that such a motion may really be given to the air in various ways. Three classes of electrical currents have been employed for transmitting sounds to a distance, and these he denominates intermittent, pulsatory, and undulatory. The first form is obtained when a current passes for a brief interval, is then followed by an interval during which no current passes, and this by a current of the same or opposite sign. In the second class a current is continually passing, but its intensity increases and decreases instantaneously, and finally, in the third class this variation takes place gradually, and may therefore be represented by a sinuous line. In his experiments on the nature of the movement of the air Prof. Bell employed a human ear, a hay style attached to the incus recording the movement communicated to it on a moving sheet of smoked glass. A very interesting series of curves produced by this means was shown upon the screen, and he explained how his experiments in this direction led him to the present form of telephone. Since the very small membrane of the ear was capable of setting in motion comparatively large bones, it seemed probable that it could cause a light piece of iron to vibrate. In the earlier form of apparatus a piece of steel spring was therefore attached to a stretched membrane of gold-beaters' skin and placed in front of the pole of the magnet, but he found on increasing the area of metal that the action of the instrument was improved, and thus was led to do away with the membrane itself. Another branch of the investigation referred to the strength of the magnet employed, and this was modified by varying the strength of current. The battery was gradually reduced from fifty cells to none at all, and still the effects were observed, but in a much less marked degree; the action was in this latter case, doubtless, due to residual magnetism, hence, in the present form of apparatus, a permanent magnet is employed. Lastly, the effect of varying the dimensions of the coil of wire was studied, when it was found that the sounds became louder as its length was diminished; a certain length was, however, ultimately reached beyond which no improvement was effected, and it was found to be only necessary to inclose one end of the magnet in the coil of wire. A number of diagrams were projected on to the screen which showed the various forms the apparatus has taken from the time of Page to the present day. An air sung in a distant part of the building was distinctly heard in the room by the aid of an improved form of Reiss' telephone, lent by Prof. Barrett, and made by Mr. Yates, of Dublin. Prof. Bell, Prof. Foster, and Dr. Gladstone then carried on a conversation with a gentleman at a distance, and utterances were shown to be audible when the transmitting instrument was held about a foot from the mouth. A discussion then followed in which Mr. De la Rue, Dr. Gladstone, Profs. Foster, Guthrie, Atkinson, and others took part. In replying to the various questions, Prof. Bell stated that his attempts to determine the amplitude of the vibrations had not been successful, and he is coming to the conclusion that the movement must be molecular. Very distinct sounds are emitted when a considerable mass of iron is employed; and further, if the iron be glued to a piece of wood an inch thick and this be interposed between it and the magnet the action still continues. Conversation has been carried on through a distance of 258 miles, but a resistance of 60,000 ohms has been interposed without preventing the action. There is a very marked difference in the manner in which letters are reproduced by the telephone. Vowel sounds are more acceptable than consonants, and, as a rule, those letters are best transmitted which involve a large oral aperture in their utterance. Finally, he finds that high sounds are produced more fully than low ones, but this question has not yet received sufficient attention.

Zoological Society, December 4.—Prof. Newton, F.R.S., vice-president, in the chair.—Mr. Henry Seebohm, F.Z.S., exhibited and made remarks upon some of the rarer eggs and birds which he had obtained during his recent visit to the Arctic regions of the Yen-e-sey, in Eastern Siberia, and gave a rapid sketch of his journey. Some of the skins were interesting from the fact that they extended our knowledge of geographical distribution, such as *Phylloscopus trochilus* and *Acrocephalus schœnobœnus*, from long. 88° E., *Anthus gustavi* of Swinhoe (*A. seebohmi* of Dresser, and *A. batchianensis* of Gray) from the same longitude, and young in first plumage of this species.—Mr. Saville Kent, F.Z.S., exhibited the plans of a Zoological Station and Museum and Institute of Pisciculture to be established at St. Helier's, Jersey. The object sought in the establishment of this institution was the provision within British waters of facilities for pursuing marine biological investigations similar to those which exist at the Zoological Station of Naples, and at the Andersen School of Natural History at Penikese Island, Buzzards Bay, U.S.A.—The Secretary exhibited, on the part of Mr. Andrew Anderson, F.Z.S., some specimens of natural history collected in India, amongst which were chicks of *Rhynchops* and specimens of *Podiceps cristatus* obtained breeding in North-Western India.—A communication was read from Mr. Henry Lee, F.Z.S., containing an account of the capture of a Risso's grampus at Sidlesham, near Chichester.—Mr. A. G. Butler read a paper in which he gave an account of a collection of lepidoptera made in Northern Formosa by Mr. H. E. Hobson.—A communication was read from the Marquis of Tweeddale,

F.R.S., containing an account of a collection of birds made by Mr. A. H. Everett in the Island of Mindanao, Philippines. Eight new species were found in this collection, and were named *Tanygnathus everetti, Mulleripicus fuliginosus, Penelopides affinis, Criniger everetti, Orthotomus nigriceps, Æthopyga bella, Anthothreptus griseigularis* and *Ptilopus incognitus*.

Geological Society, November 21.—John Evans, F.R.S., vice-president, in the chair.—Oswald Fitch, John Hadkinson, B. Holgate, H. F. Parsons, M.D., and Edgar P. Rathbone, were elected Fellows of the Society.—The following communications were read:—On the glacial deposits of West Cheshire, together with lists of the fauna found in the drift of Cheshire and adjoiding counties, by W. Shone, F.G.S.—The chair was then taken by Warington W. Smyth, F.R.S.—The Moffat series, by C. Lapworth, F.G.S.

Victoria (Philosophical) Institute, December 3.—Mr. C. Brooke, M.D., F.R.S., in the chair. The paper of the evening was read by Mr. J. E. Howard, F.R.S., and referred to the advances that modern science had made in regard to nature, and the value of "a slow but sure path of induction."

PARIS

Academy of Sciences, December 3.—M. Peligot in the chair:—The following papers were read:—On artificial production of corundum, ruby, and different crystallised silicates, by MM. Fremy and Feil. In a crucible of refractory earth is put a mixture of equal weights of alumina and minium, and calcined for some time at a bright red heat; after cooling there are found two layers, one vitreous, formed chiefly of silicate of lead, the other crystalline and often presenting geodes full of beautiful crystals of alumina. To obtain the red colour of ruby, about 2 to 3 per cent. of bichromate of potash is added to the mixture of alumina and minium. The silicate of lead on the ruby crystals is removed by the action of fused oxide of lead, hydrofluoric acid, or otherwise. A silicate of alumina (apparently dysthene) is produced by heating for some time a mixture of equal weights of silicon and fluoride of aluminium (fluoride of silicon is disengaged). Other reactions with fluorides giving crystalline bodies are described.—On invariants, by Prof. Sylvester.—On various means of accelerating the service in navigation-locks, by M. de Caligny.—Sir William Thomson was elected foreign associate, in room of the late von Baer, receiving twenty-seven votes against twenty-five for M. Van Beneden.—Report on a memoir of M. Hautefeuille, on reproduction of albite and orthose. M. Hautefeuille's process consists in keeping the elements of these minerals (free or combined), in presence of certain fused salts, such as tungstic acid and the alkaline tungstates. Thus a mixture of silica and alumina, in presence of an acid tungstate of potash at a temperature between 900° and 1,000° produces tridymite, orthose, and triclinic felspars. If the elements have been exactly proportioned, the tridymite and felspar disappear, and their elements go to increase the crystals of orthose.—On the law of absorption of radiations through bodies, and its use in quantitative spectrum analysis (first part), by M Govi. This relates to a comparison of the curves of absorption given by wedge-shaped forms of the absorbent substance.—Practical tracing of the circle which has to be substituted for a given curve of finite extent, by M. Lécomté.—Battery in which carbon is the electrode attacked, by M. Jablochkoff. Into fused nitrate of potash or nitrate of soda is placed, as the attackable electrode, ordinary coke, and as the unattackable, platina. The electromotive force varies between two and three units, and thus exceeds that of the Bunsen and Grenet batteries. The coke may be lit and put in the nitrate in a powdered state. The gases developed by the battery are utilised. The containing vessels are of iron (that for the carbon, of iron wire).—Action of oxalic acid on silicate of soda, hydrated quartz, by M. Monier.—On M. Allaire's new method of purification of fatty water of surface-condensers, by M. Hetet.—On the respiration of submerged aquatic plants, by M. Barthelemy. These plants, observed in the normal state, do not liberate gas, even in sunlight, any more than aquatic animals (the liberation observed hitherto has been caused by experiment). The true respiratory act of these plants consists in absorption of air in solution in the water, probably by the roots.—A new one-liquid battery, by M. Jourdan. The electrodes are zinc and blacklead, the liquid an aqueous solution of sal alkali.—Occultations; graphic prediction, by M. Bailly.—Observations of the spots and the rotation of Mars during the opposition of 1877, at the Rio de Janeiro Observatory, by M. Cruls. The time of rotation obtained from three values is 24h. 37m. 34s.—On a fundamental problem of geodesy; application of a general method of transformation of integrals depending on square roots (continued), by M. Callandeau.—On the rational integrals of the problem of geodesic lines, by M. Levy.—On the superficial tensions of aqueous solutions of alcohol and fatty acids, by M. Duclaux.—On some properties of boric acid, by M. Ditte. A lecture experiment is recommended, which demonstrates the liberation of heat in chemical actions. It is to add 125 grammes of water to 100 grammes of boric acid. The heat is such that an ingot of Darcet's alloy put into the mixture is fused in a few seconds.—On the formation of ultramarines and their coloration, by M. Guinet.—On the alterations of eggs, *à propos* of note by MM. Bechamp and Eustache, by M. Gayon.—On the mechanism of death produced by inoculation of anthrax in the rabbit, by M. Toussaint.—On some new mammalia of New Guinea, by M. Milne Edwards.—On compound machines, their economic produce, and the general conditions of their action, by M. de Freminville.—Process of registration and reproduction of phenomena perceived by hearing, by M. Cros (sealed packet).

GENEVA

Society of Physics and Natural History, October 4.—M. Alphonse Favre has found on the Allelin Mountain, dominating the upper part of the Saas Valley near Mont Rosa, a bed of euphotide. This name is applied to a rock formed of two elements, viz., saussurite, a leaden gray mineral, and diallage, a bright green mineral, classed among amphibolites. This bed explains the origin of the erratic blocks of that substance, which are seen in numbers in the plain occupied formerly by the Rhone glacier.—Prof. Wartmann showed two apparatus based upon the properties recently recognised by him among derived currents. One is intended to determine immediately the fraction of an electric current which traverses a given conductor. The other is a current-inverser, in which the production of the extra-current is avoided, because the current always finds its passage.

CONTENTS